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**Investigation into what makes effective professional development with an intervention approach such as CASE**

Lecky, Martina

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Investigation into what makes effective professional  
development with an intervention approach such as CASE

by

Martina Anne Bernadette Lecky

Research Based Thesis submitted in fulfilment of the  
requirements of the Doctorate in Education

King's College, London, University of London

## Abstract

The focus of the RBT (Research Based Thesis) was teachers' professional development (PD) within a school undertaking the innovative CASE (Cognitive Acceleration through Science Education) project. The study involved a case-based approach that drew upon a range of mixed methods to explain the process of how teachers learn as they develop an ownership of the CASE methodology. The literature review placed this research in the developing field of professional adult learning, where it has been recognised that more research is required to consider equally both professional learning processes and the pedagogy of how students learn. In line with the founders of CASE, the RBT examined teachers' development through an active, conscious process.

The two main research questions focused on teachers' PD and are as follows:

**Question 1** *How does a teacher change in terms of his/her classroom skills, attitudes/beliefs and knowledge/understanding of the theoretical underpinnings of CASE as he/she develops an ownership of the methodology and how can the nature of the change process be characterised?*

**Question 2** *How important to the process of change are the mediating factors of experimentation, collaboration, lesson observation with feedback and modelling?*

In addition, student outcomes were also included in the study mainly to give a clear indication of the effectiveness of the CASE project, which relates to the third subsidiary question:

**Question 3** *Did the students show significant cognitive gains, with the primary focus being the whole cohort's results?*



A case study methodology was used, drawing upon mixed-methods based upon a pragmatic paradigm. The study was carried out in my own institution during the academic year 2007-2008 where I was the upper school Deputy Headteacher, and involved three participant teachers. Qualitative teacher data was collected through three lesson observations and semi-structured interviews – one per term. Quantitative data was also collected at three different stages to measure students' cognitive development using the established Science Reasoning Tests (SRTs).

The research tools were developed using an analytical framework which contained a description of each construct and/or process contained in the two main research questions. The development of teachers' classroom practice was solely studied using a systematic lesson observation schedule, whilst all the other constructs were researched either directly or indirectly through the semi-structured interviews.

The BERA (British Educational Research Association) guidelines were used to consider ethical issues especially those relating to carrying out research in my own institution with a small number of participants as well as my multiple roles. In terms of PD inputs, the participant teachers attended six half termly in-service sessions and observed a demonstration lesson conducted by me at the beginning of the year.

The approach to analysis used a combination of inductive and deductive methods. The interview transcripts were initially coded using the analytical framework with respect to the different constructs, but the themes were inductively identified. The main deductive approach to analysis was the use of established PD models to give a level to teachers' classroom practice based on a novice-expert five stage model and their sense of ownership using a non-

linear stage model. In relation to question 3, students' cognitive levels were compared with norms to determine whether cognitive gains had been made beyond expectation.

A common issue in CPD (Continuing Professional Development) research is that the tools used for development can often overlap with methods of data collection. Careful consideration was given to this in the methodology/method section so that the methods for collecting evidence and the PD inputs were made explicit.

In terms of the main findings, in relation to question 1, there were similarities in teachers' respective descriptions of how their knowledge of the CASE methodology developed. They referred to gaining confidence in their skills, which was supported by lesson observation. In terms of question 2, the interpretations of the responses of the two teachers with the least experience indicated differences in how they learned as well as the mediating factors that best supported their learning. This supports existing literature that individual differences play an important part in teachers' PD.

No significant cognitive gains were made by the students as determined by the analysis of their pre- and post-test SRT scores; the analysis of students' cognitive gains in terms of standardised norms was, however, questionable and therefore the appropriateness of SRTs to measure cognitive development needs to be considered in any future research.

In relation to teachers' PD, the main recommendation for the future was the development of a contextualised PD model of CASE to allow for teachers to understand their development and to support CASE tutors in considering how teachers learn and develop an ownership of the

CASE methodology. This would support teachers and tutors in being more deliberate in their respective practice.

## **Acknowledgements**

I would like to thank Professor Peter Kutnick, my main supervisor, for his continued support and advice throughout the IFS and RBT; I have most certainly learnt a lot from his tutelage, especially his attention to detail and guidance about the process of social scientific research.

I am indebted to Professor Philip Adey, my secondary supervisor, who was one of the founders of CASE, which has been a passion for me since I was first introduced to the project during my PGCE course; it was an epiphany for me in terms of a psychological model to understand learning and development. My involvement in CASE has shaped the teaching part of my career and allowed me to work with lots of different teachers, many of whom have also been inspired by the pedagogy. I would also like to thank him for his guidance throughout the research and write-up stages of the RBT.

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## **Section I: Background to the Research Based Thesis (RBT)**

This section outlines the origins of the research in terms of my interest in, and involvement with, the CASE project, especially teachers' adoption of the innovative classroom methodology.

### **CASE Project**

The Cognitive Acceleration through Science Education (CASE) project (Adey, Shayer & Yates, 2001) was developed at King's College, London, and is an intervention scheme which aims to accelerate students' cognitive development through a scientific context. In addition, it was a piece of research in the 1980s, which had the teachers' adoption of this new approach as one of its primary focuses. After the initial CASE research phase (1984-1987) it was due to the founders' consideration of the professional development (PD) of teachers, and the well developed resources of the original thirty-two activities, that the project can be seen as an exemplar of educational research. With its well-grounded theoretical framework, CASE has had a direct impact on classroom practitioners (McGuiness, 1999, Leat, 1999, Higgins et al., 2005) and participant students' attainment in public examinations (Adey & Shayer, 1993).

### **Origins of Interest**

I was introduced to CASE as a PGCE (Post Graduate Certificate in Education) student during a workshop session at The University of Sussex (1992-1993) due to one of my lecturers being a CASE tutor. Both the CASE methodology and tenets of constructivism resonated with me in terms of students' learning and development. I joined an all girls,

Church of England, voluntary-aided, comprehensive secondary school in central London as a NQT (Newly Qualified Teacher) in September, 1993. Shortly after joining, I was keen to try the CASE activities with students and therefore asked the Head of Science if I could trial the activities with some Year 7 classes. I was given permission and used some support periods on my timetable to work with three classes. Whilst I found the activities very challenging, I had the advantage of repeating each activity with two other classes and working in conjunction with three Science teachers who all became enthusiastic about the methodology. I was fortunate that in September, 1995, Westminster LA (Local Authority) paid for all its secondary schools to send two teachers to join the fifth cohort of schools to be professionally trained in the pedagogical approach of CASE as part of the King's College, London, two year INSET (IN-Service Training) programme (1995-1997).

My colleague and I used the two-year programme to support us in setting up the scheme in our school which involved pre- and post-testing all the students; the thirty-two activities were delivered to Year 7 and 8 classes, following the recommended one lesson every two/three weeks. After one year, I was given the position of CASE co-ordinator. During this time, I was encouraged by the CASE tutors at King's to consider taking on a trainer role which involved working with other trainers to compile a portfolio of evidence. By 1999, I had become an accredited CASE trainer and a member of the CA (Cognitive Acceleration) tutor group; I have maintained my involvement with CASE through the training of teachers in my own school and other schools through either discrete INSET days or a CASE network of six schools (2001-2002).

Through participation with CASE, both as a teacher and trainer, two issues arose: one on a student level and the other on a teacher level.

- *Student level - students' motivation to engage in CASE lessons*

My IFS (Institution Focused Study)<sup>1</sup>, September 2005 - August 2008, focused on the possible relationship between students' motivational orientation and their cognitive gains through being involved in one year of the CASE programme. This issue built upon a conjecture by Leo and Galloway (1996) that some students do not engage in CASE lessons because of their type of motivational orientation and therefore do not make the same level of cognitive gains as students with an adaptive motivational orientation<sup>2</sup>. The IFS research did not find any clear or conclusive relationships between students' motivational orientations and their cognitive gains; the results were in line with the findings of a much larger longitudinal piece of research, looking, in part, at a similar possible connection between the above mentioned constructs (McLellan, 2006<sup>3</sup>).

- *Teacher level - internal school factors and processes that could support teachers to develop the skills and knowledge necessary to deliver CASE lessons effectively*

Due to the high turnover in teaching staff at my school I have been involved in training numerous staff from a variety of backgrounds with CASE. This had brought me to a

---

<sup>1</sup> The IFS used a quantitative approach, measuring students' motivational orientation through questionnaires and their cognitive level through Science Reasoning Tests (SRTs).

<sup>2</sup> Their conjecture is discussed in Section III.

<sup>3</sup> This research is expanded upon in Section III.

juncture where I wanted to research and evaluate what a school can do to support the PD of teachers with CASE, considering the constraints and difficulties caused by a transient staff population. Fullan (2001) notes that: *‘Very few programs plan for the orientation and in-service support for new members who arrive after the program is started. And arrive they do – chipping away, however unintentionally, at what is already a fragile process (p90).’*

### **Reflections on the CASE methodology**

Thus after completing the IFS, I decided to turn my attention to the process of change for teachers involved in delivering CASE lessons. I was particularly interested in specific and notable changes that teachers needed to make in order for both their classroom practice, and pedagogical understanding of how students’ develop cognitively, to be altered.

A common issue that I had observed was how teachers dealt with the resolution of the cognitive conflict pillar<sup>4</sup> with the students. As Adey (2004) wrote, in his book on PD: *‘They get uncomfortable watching their charges struggling, and too often rush in with answers which they believe will be helpful but which, in the context of cognitive acceleration, actually short-circuit the process (p21).’* From CASE observations, I had witnessed the importance of the establishment of a new relationship between the teacher and his/her students in CASE lessons as both the expectations and classroom dynamic are likely to be profoundly different to content-based lessons. Joyce and Showers (2002)

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<sup>4</sup> In all CASE lessons the five different cognitive activities that students can experience are called ‘pillars’. These are: concrete preparation, cognitive conflict, construction, metacognition and bridging. These are expanded upon throughout the literature review.

identified that teaching ‘*new behaviour to students*’ (p81) was one of the skills teachers needed to master as they learn new knowledge and skills. It is exactly the issue raised by Adey regarding students’ discomfort that they concluded can often lead teachers to abandon a new strategy after a few trials.

On a pedagogical level, Adey gave a second explanation for the teachers’ errors based upon the psychological theoretical framework of the project: ‘*Another reason that managing cognitive conflict effectively is so difficult is that the construction zone is going to be different for every child in the class* (p21).’ Thus teachers’ pedagogical knowledge of CASE needs to be well developed so that they can put their understanding into practice; teachers need to deal with the complexities of every lesson where students’ different cognitive levels result in different conflicts for individual students. In addition, the classroom set-up in a CASE lesson, in terms of the dynamic amongst the students, is one where the constructivist approach to learning relies on collaboration (Adey & Shayer, 1994). This is likely to be different to content-based Science lessons where there is far less reliance and emphasis on students sharing their ideas with their peers (Kutnick et al., 2005).

### **Aims and Context of the Research**

Adey (2004) cites several pieces of empirical research concerning the complexities of PD with regard to CASE and in the final chapter proposes a model of the factors influencing PD and how they affect and connect with each other. In terms of individual teachers, it is suggested that their ownership and acceptance of the theory is what directly causes

student change. As there has not been any published research on the actual process of change that teachers undergo as they become effective CASE practitioners, the main aim of the RBT (Research Based Thesis) is to conduct research to try to explain the change process rather than describe factors that can affect it.

In 2007 when I embarked on the planning of the RBT, I was the Deputy Headteacher at the central London school I joined in 1993 as an NQT. The school had been judged as outstanding by Ofsted in its most recent inspection, partly based on its public examination success in terms of students' high levels of attainment and achievement. The school has always been heavily oversubscribed for entry into both Year 7 and the Sixth Form. Since 1995, I had continued to oversee the delivery of the CASE project with Year 7 and 8 classes. My employment status became a major factor for consideration on both a methodological and design level; this is expanded upon in Section IV.



## **Section II: The CASE project**

*“The issue is, just how general can one get?”(Adey, 1997)*

This section intends to expand on the background to the CASE project in terms of why it was seen necessary to develop such a scheme in 1980s/ 1990s and, in addition, the psychological models that underpin it. At the same time, it will relate the theory and practice to the PD of teachers, illuminating some of the possible processes and barriers that need to be considered when exploring teachers’ PD with the scheme. It ends with a description of the CASE approach to CPD (Continuing Professional Development). Finally, a précis of other intervention approaches, so that CASE can be seen in the context of other research and programmes, can be found in appendix 1a. Whilst this research is focused on the CASE project there have been other CA schemes which Adey and/or Shayer have been directly involved with most notably CAME<sup>5</sup> and CA@KS 1 – Let’s Think- scheme<sup>6</sup>, which are drawn upon in the literature review.

### **CASE and the National Curriculum**

The CASE intervention programme aims to challenge students through specifically designed activities to think beyond their current level of cognition with regard to Science-based tasks. Whilst the primary research and pilot studies were carried out in the 1980s, before the introduction of the National Curriculum in 1989, Adey and Shayer helped to

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<sup>5</sup> CAME – Cognitive Acceleration through Mathematics Education (Adhami et al., 1998)

<sup>6</sup> CA@KS1 (Cognitive Acceleration at Key Stage 1) was a project which started in 1999 in the London Borough of Hammersmith and Fulham to explore Science CA with primary school students in Year 1. The materials for schools are published as Let’s Think! (Adey, Robertson & Venville, 2001). .

elucidate an underlying flaw with respect to students' cognitive abilities and the new national levels of scientific attainment targets.

Adey and Shayer carried out an analysis of Science curricula<sup>7</sup>, using the taxonomies described in *Towards a Science of Science Thinking* (Shayer & Adey, 1981), in terms of identifying the Piagetian demands of the then seventeen Science attainment targets, with a range of 1 to 10 levels for each target. Once this analysis had been completed, Shayer (1991) drew upon the data to predict that there would be a gap for fourteen year olds between the expected level of attainment in Science, set out by the Task Group on Assessment and Testing (TGAT), and the lower projected levels of attainment based on Piagetian levels of fourteen year olds using the CSMS (Concepts in Secondary Mathematics and Science) data (Shayer & Wylam, 1978). In simple terms a large percentage of the students was not expected to have the necessary levels of cognition, aged fourteen, to understand the scientific concepts outlined in the attainment targets. The implication of this on a teaching and learning level was that the scientific concepts being taught would be cognitively too advanced for a certain proportion of the students who were expected to understand them.

Therefore the National Curriculum gave the CASE team a clear basis and national agenda to make their arguments as to why it was necessary for schools to take part in the project; secondary school Science teachers needed to accelerate the process of cognitive development so that more students, and in less time, attained higher order thinking skills

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<sup>7</sup> Nuffield Science – Biology, Chemistry and Physics - was used for the analysis.

– formal-operational thinking – and, therefore, could cope better with the conceptual demands of the National Curriculum.

### **Psychological Model – Piaget**

The CASE project is underpinned by Adey and Shayer's interpretation of Piaget's psychological framework of cognitive development of children<sup>8</sup> through the interaction of the maturation process of the central nervous system and social/experimental activity (Adey & Shayer, 1994). Piaget's work focused on the philosophical nature of knowledge and not on the psychological nature of individual children (Bliss, 1995). Piaget's stage theory states that school-aged children's understanding develops through three main stages of cognition -*pre-operational*, *concrete* and *formal- operational thinking* (Shayer and Adey, 1981).

The application of these stages of development to the CASE project is centred on the processes that are likely to encourage and therefore accelerate an individual's cognitive development. Using the CSMS data it is likely that in the early secondary school years, the majority of students will be *concrete* operational thinkers – meaning they can describe, but can only explain concepts via reversibility through making basic connections between two variables (Shayer & Wylam, 1978).

Adey (1993) suggests that cognitive development is influenced by three factors:

---

<sup>8</sup> The work of Piaget is extremely significant to the RBT. Whilst there are many differing and converging interpretations of his writings, including critiques of children's early development (Donaldson, 1978), for this area of study the predominant interpretation is Shayer and Adey's (1981) and how this is used and applied in the CASE project.

- potential – every child has different genetic makeup;
- maturation – time and development of the central nervous system;
- environment – physical, social and, above all, cognitive stimulation.

This psychological framework is part of a standard introduction to CASE for new teachers (Adey, 1993); it is presented as a useful qualitative framework to consider students' cognitive development especially in relation to the plasticity of the brain (Adey et al., 2007) and the role that teachers can have as part of the environment factor.

### **The Process of Cognitive Development**

Cognitive development is unidirectional unlike the process of learning (Adey & Shayer, 1994). If students are to advance in their thinking, they need to alter their cognitive structures. As mentioned earlier, Piaget was one of the first to propose constructivism in terms of children constructing their own knowledge through a process of equilibration which drives development by interacting with the natural maturation process within certain limits (Bliss, 1995); this happens through assimilation and accommodation, which are aspects of one process -equilibration- which is required for cognitive development.

For an individual to allow a new stimulus to fit then his/her cognitive structure needs to alter -accommodate it- so that the new stimulus can be assimilated within existing structures; on a physiological level it is proposed that there must be alterations in the neural network (Adey & Shayer, 1994). As part of the CASE INSET, teachers are presented with the model above which centres on students experiencing a '*somewhat*

*surprising event*’ compared with an event which is too simple or complex (Adey, 1993). By relating this process to CASE activities, teachers are helped to see the importance of the cognitive conflict which they need to help all students experience in CASE lessons.

### **Vygotsky and Intervention versus Instruction**

As part of the CASE two-year INSET programme (Adey, 1993), time is given to teachers to consider the types of interactions that should occur between students, and collectively and/or individually with their teacher during the different ‘pillars’ -cognitive activities- of the lessons. As mentioned by Adey (2004) in Section I, this requires teachers to understand that the cognitive challenge is different for each student which therefore affects the types of interactions that can occur. The model about students’ different levels of conflicts, and their abilities to resolve them through social mediation, is based on the work of Vygotsky (1978). His model of learning focused on the necessity for social collaboration during cognitive activities, indicating that learning and development are social processes. Vygotsky proposed the ‘*Zone of Proximal Development (ZPD)*’ which considered the gap between students’ actual level of cognition and their potential for a higher attainable level during challenging activities:

*‘It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (p86).’*  
(Vygotsky, 1978)

In interventional learning environments, it is the teacher's role to facilitate an individual's development beyond his/her current level of cognition (Adey & Shayer, 1994) through social construction and mediation<sup>9</sup>. Therefore teachers rely heavily on the discussion between students in CASE lessons for all cognitive activities especially construction. Based on anecdotal evidence, the ability of a teacher to assess students regularly throughout a CASE lesson is a striking feature of a competent CASE practitioner as this regular assessment allows excellent discussion to flow in a variety of -possibly unexplored- directions. This can be seen to relate the intuitive practice of an expert practitioner (Berliner, 1986).

The application of the ZPD by a CASE teacher makes him/her consider the students' pre-test Piagetian levels<sup>10</sup> in the context of the CASE lesson which will have an explicitly given Piagetian level. This helps the teacher to understand the differences in the way students are challenged; as mentioned in Section I, the aim of the lesson is not that all students solve the problem, but that they experience some kind of conflict which they may or may not be able to resolve.

It is worth mentioning again that this is one of the hardest elements of CASE lessons that teachers need to adjust to; allowing students to struggle, and walking away from an individual student who is, or a group of student who are, still grappling to resolve the

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<sup>9</sup> The role of the teacher as a mediator to the process of cognitive development was very much based on the work of Feuerstein and the Instructional Enrichment intervention programme and the MLE- Mediated Learning Experience (Shayer & Adey, 1993, Adey & Shayer, 1993)

<sup>10</sup> Piagetian Levels are derived from the students' scores on the pre-test they take at the beginning of the course called Science Reasoning Task (SRT). The standard SRT for Year 7 students is the Volume and Heaviness Task. SRTs will be discussed in Section IV with respect to research procedures and tools.

conflict, requires a fundamental change from the teacher in terms of his/her approach in the classroom (Adey, 2004). Therefore part of the process of change for teachers is one about their role in the classroom; teachers have to become facilitators of cognitive activities rather than instructors of knowledge. Through this change in role, the relationship and dynamic in the classroom between the teacher and his/her students, and between the students themselves, will have to change for CASE activities to be effective. As already mentioned, Joyce and Showers (2002) emphasise the need for PD programmes to consider how students respond to a change in the classroom dynamic. In addition, it relates to the initial problems that teachers face when trying to change their practice, where knowledge and beliefs become influential factors (Borko & Putman, 1995, Supovitz & Turner, 2000).

The pedagogy of how students develop cognitively is embedded in an interventionist approach rather than an instructional one (Shayer, 2002). Vygotsky (1986) spent time considering the interactive relationship between ‘spontaneous’ and ‘non-spontaneous’ (or learning-related thinking), which he proposed were necessary for cognitive development: *‘We believe that the two processes – the development of spontaneous and non-spontaneous concepts – are related and constantly influence one another. They are parts of a single process (p 157).’* The relationship between instruction and intervention is extremely relevant when considering the CASE project in terms of the type of teaching that promotes dependency versus capability amongst learners. Whilst the scientific content used in CASE can be seen as the ‘vehicle’ that allows each reasoning pattern to be developed, students still require knowledge, possibly misconceptions, that they need to

draw upon in order to experience the cognitive activities. The difference between instruction and intervention is discussed early in CASE INSET as it helps teachers to consider their approach and role in content-based lessons and how it needs to be altered in CASE lessons.

The quotation by Adey at the beginning of this part of the introduction section: *'The issue is, just how general can one get?'* focuses on general and educable skills such as the reasoning patterns that the CASE project tried to develop in students who participated in the original scheme. Adey does not advocate, however, that education should take a heuristic approach, but that suitable contexts, such as Science, lend themselves well to developing these higher order thinking skills. The launch of the new KS 3 curriculum in September 2008, QCA<sup>11</sup> (2008) recognised the need to focus less on the content and more on a skill-based approach with a curriculum that emphasises the 'Big Ideas'. In terms of Shayer and Adey's position about the cognitive demand of the National Curriculum, this can be seen as a movement in the right direction through the recognition of students' skills and learning processes which are part of development.

Some researchers within the situated-cognition movement have tried to discredit any measurement of general intelligence due to the differing performance of individuals with a particular thinking skill -e.g. proportionality- when the context has changed (Adey, 1997). Whilst Adey is able to give alternative explanations and interpretations to the results where significant differences were measured when the context was changed, he does recognise and value their contribution to this ontological debate about intelligence

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<sup>11</sup> QCA - Qualifications and Curriculum Authority



and higher order thinking skills. These debates are partly why there have been some interventions that focus on developing students' general thinking ability whilst others focus on subject-specific skills (McGuinness, 1999); this is expanded upon in appendix 1a.

### **CASE Activities: Reasoning Patterns /Schemata and the Five 'Pillars'**

The materials of the CASE project include a teacher's and technician's guide to the thirty activities. The guide is very explicit as the practical aspects of each activity are used to generate data to support the main cognitive challenges and therefore should not detract from the primary focus of the lesson – to challenge students cognitively. The basis of all CASE activities is one of the seven reasoning patterns, which is developed through the five 'pillars'.

#### **Reasoning Patterns**

Adey and Shayer used the different schemata<sup>12</sup> (which they termed reasoning patterns), identified by Piaget and Inhelder, that characterise a *formal* operational thinker and each activity focuses on one of the seven main reasoning patterns (Adey, Shayer & Yates, 2001). For example, the first five out of the thirty activities that makes up the CASE materials deal with the control and exclusion of variables. The cognitive demand, based on Piagetian levels, predicts that the majority of students aged 11 to 12 years old will not have the level of cognition to control variables (only approximately 40% of students will

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<sup>12</sup> According to John Flavell (1985), this is an incorrect translation – it should be schemes

have the cognition necessary to deal with this activity in a fairly straightforward way<sup>13</sup> (Adey, 1993). Therefore this is the starting point whereby students are challenged to think about this reasoning pattern through a range of activities in a scientific context.

## **Pillars**

The ‘five pillars’ can be seen as a structural part of each activity. They are described as different cognitive activities that the students should experience in a lesson and are termed: *concrete preparation*, *cognitive conflict*, *social construction*, *metacognition* and *bridging*. They do not represent a sequential order of discrete stages in a lesson, but are best understood as parts of a cyclical process where several whole, or parts of a, cycle(s) may occur in one lesson.

The success of a CASE lesson depends on how well teachers can facilitate and control these cognitive activities. For teachers to facilitate each ‘pillar’ effectively, they need to understand the reasoning pattern themselves in the context of Science so that they can develop sophisticated questioning skills; teachers need to be able to probe the students’ thinking without leading or affirming their ideas, but instead move the discussion to involve other students in order to reach a consensus or continue the debate. Implicit in each pillar is the need for students to be active and conscious participants throughout the whole lesson. Therefore a large part of the PD of teachers with CASE is to develop their ability to use the comprehensive lesson plans and adapt them to each class so that the cognitive activities become a ‘real’ experience for the students. The complexities

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<sup>13</sup> This % is based on the CSMS data generated in 1976 (Shayer & Wylam, 1978). These norms have been re-assessed and have found a significant decrease in the Piagetian cognitive levels of eleven year olds compared to the 1976 data (Shayer, Ginsburg & Coe, 2007)

involved in this cannot be underestimated and that is why Adey and Shayer (1994) advocated a two-year programme for the PD of teachers with CASE.

### **Approach to CPD**

The CPD approach by the founders of the CASE project has been an evolving process since the infancy of the scheme in the 1980s, having changed considerably from the initial research. During this phase, the focus was on the research team working closely with one teacher and class from each of the CASE schools rather than the whole department as the other classes were being used as control groups. As the two main sources for this sub-part on CPD are from Adey and Shayer (1994) and Adey (2004), they are not repeatedly referenced.

### **Influencing Factors**

Adey's experiences of working abroad, primarily on the PKG<sup>14</sup> (Pemantapan Kerja Guru) project in Indonesia, had a major influence on the development of the CASE PD model. One of the main lessons the CASE team took from the project was the gradual nature of the change process for teachers as they developed an ownership of a new teaching method and therefore that PD needed to be considered as a long-term programme. In addition, a strong element of the project had been instructor-led where the teachers experienced the new materials during in-service workshops led by instructors and then worked with instructors in their own schools, using their experiences as a source of reflection at the next workshop. Therefore, the partnership of instructors working closely

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<sup>14</sup> Led by the Indonesian government, this project was launched in 1979 throughout the country; its primary aim was to try a new approach to in-service PD of secondary school teachers, trying to shift their focus in the classroom from instruction of knowledge towards a constructivist approach to students' learning. Adey joined on a part-time basis in 1981.

with new teachers, both inside and outside of school, was an important feature of this PD model.

The research of Joyce and Showers (1988), in terms of the use of *theory-demonstration-practice-coaching* in PD, was also influential to the CASE team. Joyce and Showers found through empirical work that to achieve the desired outcomes of an improvement in students' learning, it was necessary to achieve the outcome of the transfer of training to teachers termed *executive control*; this related to the CASE team's belief in the development of teacher ownership of the methodology as part of the PD programme. In addition, the researchers' ability to work directly with teachers in school, rather than just through in-service workshops, was one of the main features as to why this model resonated with the PKG project. Interestingly, in a more recent publication on their model, Joyce and Showers (2002) have shifted from technical to peer coaching where teachers work collaboratively to plan and develop lessons partly due to time and money being a constant constraint; they do not, however, explain why technical coaching has been omitted especially as it had been found to be effective in previous research. The use of technical-type coaching has remained a core feature of the CASE PD model. Adey & Shayer make no apologies for their INSET programme being a transfer of the methodology from 'experts' to 'novices'; this programme is expanded upon in the next sub-part.

## INSET

Once the CASE PD model had been developed, the two-year programme was launched with the first cohort of schools in September, 1991. It involved seven in-service days at King's College led by the CASE tutor team and five half-day visits by CASE tutors to schools. The core elements of the programme were the appointment of a CASE co-ordinator whose roles were to attend all the INSET days with one member of the department<sup>15</sup> and to lead the implementation of the scheme at his/her school. The INSET days allowed for time to be spent considering the pedagogy, trialling the course materials and reflecting on the methodology with colleagues. In addition, it introduced teachers to activities that they could use with their department. This led to the development of the King's BP Thinking Science INSET pack (Adey, 1993), which included ten possible INSET sessions, including a range of activities that CASE co-ordinators could use to support the overall programme at their respective schools; these activities, however, were never designed to replace CA tutors. The school visits had a range of purposes and PD inputs, including meetings with SLTs (Senior Leadership Teams) and science departments, lessons observations with feedback and demonstrations. The primary aim was, through these inputs, to support teachers to develop their ownership of the methodology.

The original CASE PD approach was used by Fraser et al (2007) as a comparison to the government-led National Literacy Strategy (NLS)<sup>16</sup> because it allowed teacher ownership to be developed through a transformative learning process. It was suggested that CASE

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<sup>15</sup> The second person could be the same or a different member of the department each time

<sup>16</sup> The NLS was established in 1998 in England with the original intention of improving the teaching of English in primary schools in part through a daily literacy hour.

initially started off in a transmission mode of delivery, moving to a transformative approach as the PD progressed. This interpretation could be because of the emphasis that Adey and Shayer (1994) place on teachers understanding the psychological models that underpin CASE, but no reference was made to the nature of the INSET sessions, which most certainly had not been designed to be through a transmission mode of learning. The CASE team's PD model on how teachers learn and develop is aligned with students' development and is outlined in the next sub-part.

### **How teachers develop: constructivism**

The CASE pedagogy is built upon the premise that the development, rather than necessarily the learning, of individuals is brought about by an active process. Whilst the project's background focuses on children's cognitive development, the founders have applied the constructivism to the development of teachers brought about, in part, by conceptual changes and through reflection (Adey, 2004). Adey and Shayer (1994) state that: *'Building some theory into an INSET programme .. is an essential step in the transfer of ownership of the methodology from the researcher to the teacher. This is constructivism for teachers. We understand that students must construct knowledge for themselves and, in CASE, must construct also their own reasoning patterns from the materials that we give them. So also must teachers construct the methods of cognitive intervention for themselves? (p157)'*

Adey's earlier quotations (2004) in Section I highlight the difficulties encountered by teachers when trying to facilitate CASE lessons effectively. These difficulties are very

much part of the cognitive process for teachers as they develop the skills and knowledge, which Adey refers to as conceptual changes, to become effective practitioners. The expression '*must construct also their own reasoning patterns*' centres on the actual developmental process which is characterised by new reasoning patterns being formed, which should subsequently alter the knowledge that teachers can assimilate. Adey and Shayer (1994) are therefore advocating that the five CASE pillars that teachers try to facilitate for students are also the same cognitive activities that teachers need to experience to bring about their own development. Therefore the five pillars of CASE are not exclusive to the classroom in terms of cognitive activities that the students experience; they are experienced by teachers as they develop their ownership of the methodology. This is why collaboration with other colleagues and CASE teachers and time to reflect are key elements to the CASE team's INSET programme.

Borko & Putman (1995) state that: '*a project's assumptions about how teachers learn should be compatible with its assumptions about how students learn* (p58).' CASE certainly fits this description in terms of constructivism; through its cognitive activities, CASE allows students to construct a new understanding of the world through an active and conscious process - the same can thus be applied to teachers in terms of them constructing a new understanding of their role and practice in the classroom through alterations in their beliefs and knowledge about how students learn, which Shayer (1991) states: '*require the development of fresh teaching skills which do not at present form part of the good Science teacher's repertoire* (p23).'

Regarding barriers to the change process from a constructivist perspective, a cautionary note was made by Desforges (1995) when considering changes to teachers' knowledge in terms of the problems associated with application. He cited studies that have found that teachers tend to 'close-down' rather than 'open-up' when dealing with anomalous data; their first tactic was to try to return to normality. He recommended that PD needed to be carefully handled and that: '*learning cannot be simply equated with experience, nor can it be expected to flow readily from it* (p393).' However, Mevarech (1995) posited that barriers, which she termed 'interference', may be a necessary part of the learning process, which is aligned with Adey and Shayer's (1994) application of cognitive conflict to teachers' PD. Thus taking both points into consideration, it could be argued that radical change is less likely to succeed if teachers are satisfied with their current conceptual understanding, especially how it relates to their role in the classroom. Adey (2004) supports this position, relating it to teachers' prior conceptions, which need to be faced in PD programmes; he posits that this is one of the reasons why change is often a slow process and cannot be achieved through instruction.

### **Teacher Ownership**

Throughout Section I and II, the emphasis the CASE team has placed on the construct of teacher ownership of the CASE methodology has been highlighted (Adey, 2004).

Since the first edition of the programme materials became available in 1989, the subsequent two revisions (1995, 2001) have incorporated feedback provided by CASE tutors and teachers who were involved in the King's College based INSET programme, as well as important technical support for teachers, including adaptable note sheets and



spreadsheets. The CASE scheme encourages teachers to adapt lesson plans especially in terms of the flexibility required to manage students' responses and for teachers to consider using different bridging examples. On the other end of the spectrum, there is plenty of research from a wide variety of backgrounds that involves teachers actually devising the original course materials and lesson plans with the initial focus from the researchers (Osborne, Erduran & Simon, 2004b, Ogborn 2002, Cho, 2002, Lock & Glackin, 2009). This level of involvement of teachers is clearly different to programmes<sup>17</sup> like CASE, Somerset Thinking Skills (Blagg et al., 1993) and Instrumental Enrichment (IE) (Feuerstein et al., 1980), which are based on specialist-led materials.

Whilst IE was very influential to the development of CASE, most notably the role of the teacher in the classroom (Adey and Shayer, 1994), their respective approaches to PD in relation to teacher ownership reflect a fundamental difference. With IE course materials, no adaptation or alteration of the original resources is permitted (McGuinness, 1999). Blagg (1991) stated that this meant that the programme: '*appeared to be cloaked in psychological mystique* (p124).' An interpretation of this position is that teachers do not need to develop an ownership of the methodology and therefore their engagement with the resources could be through a more transmission-type approach. The process by which teachers learn and develop would most certainly not match the approach for the students and is possibly why studies into IE have shown mixed results in terms of student gains (Shayer & Beasley, 1987, Blagg, 1991).

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<sup>17</sup> Both Somerset Thinking Skills (STS) and Instructional Enrichment (IE) are expanded upon in appendix 1a, looking at intervention approaches.

Teacher ownership in the contexts discussed so far relates to Fullan's (2001) position that there is a dilemma and conflict running through educational change literature, relating to a divide between the fidelity and evolutionary perspectives; CASE would certainly advocate an evolutionary model in relation to teachers being encouraged to invent CA activities as part of their ownership of the methodology (Adey & Shayer, 1994).

To conclude, this section of the RBT has shown that CASE requires teachers to understand and then apply their knowledge of the psychological models that underpin the project. It also involves a fundamental shift in classroom expectations, roles, dynamic and outcomes. For the majority of teachers their PD with the CASE project will happen whilst they are coping with the many demands and pressures of their other roles and responsibilities. This highlights again why it is necessary to conduct research into how the process of teacher change through PD programmes can be best understood.

## Section III: Literature Review

### *Introduction*

*‘My search is driven by the goal of ascertaining the attributes of excellence ...the basis for extolling that our profession truly does have recognisable excellence which can be identified in defensible ways (p1).’ (Hattie, 2003)*

Hattie’s position is certainly supported by the extensive literature on PD and initial training of teachers<sup>18</sup>. Irrespective of the authors’ positions or areas of expertise, in all the work that contributes to this literature review, there is a clear recognition, either implicitly or explicitly, that teachers play the key role in creating the environments where students can learn and develop and thus are the factor that can have the greatest impact on student achievement (Hawley et al., 1984, Hattie, 2003). Joyce and Showers (2002) even take the position that all staff development should be focused solely on improving students’ achievement.

### **Professions and Recent Trends in CPD**

In this opening part to the literature review it is worth considering what is meant by a profession due to the focus on PD. Stigler and Hiebert (1999) state that a profession is about the knowledge base and how it evolves rather than certificates and controls. When considering teaching, there have been those who have argued that it is a quasi-profession (Strike, 1990) partly due to the level of involvement of the government most notably with the introduction of a National Curriculum in 1989 (Whitty, 1989) as well as a culture of

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<sup>18</sup> Hattie’s (2003) synthesis of a large number of studies found that the variable that has the greatest effect on students’ achievement, other than the differences between students themselves, was teachers.

target-setting and league tables (Fielding, 1999). At this time, governance of the education system became one where educationalists, including teachers, were no longer given the autonomy to decide the curriculum and even assessment procedures.

Before 2000, when the English and Welsh General Teaching Councils<sup>19</sup> were established, there had been no regulatory bodies for the teaching profession in England, Wales, and Northern Ireland unlike the Medical and Law equivalents. The focus on school effectiveness in the UK, for the last two decades, has certainly led to a greater emphasis on effective CPD and its relationship to school improvement (Day & Sachs, 2004, Frost et al., 2000<sup>20</sup>), in part, through National Strategies (Bolam & McMahan, 2004) and standards-driven reform (Elliot, 2004). Some academics have suggested that a move away from ‘one-off training days’ to ‘lifelong learning’ has been born out of these cultural and political changes (Day & Sachs, 2004, Middlewood et al., 2005). The national agencies involved in education have certainly given their support and backing to schools that focus on learning communities (Bolam et al., 2005) with the status of ‘Training School’ being one of the designated types of specialism that schools can apply for from the joint partnership between DCSF<sup>21</sup> and TDA (TDA, 2010)<sup>22</sup>.

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<sup>19</sup>The GTCS - the General Teaching Council for Scotland was one of the first teaching bodies to be set up in the world in 1965. GTCNI – the General Teaching Council for Northern Ireland was set in 2002

<sup>20</sup> The Canterbury Improving Schools Scheme CANTIS ran from 1994 to 1998 to develop a model of teacher led- school improvement in partnership with Higher Education.

<sup>21</sup> DCSF was re-designated in 2010 to the Department for Education (DfE)

<sup>22</sup> DCSF – Department for Children Schools and Families and TDA – Teacher Development Agency for Schools. There are currently 214 schools in England and Wales that have Training School status, which are to be superseded with Teaching Schools.

## PD Literature and EPPI Centre Reviews

Due, in part, to the eclectic nature of PD research, combined with the different perspectives and approaches, it has resulted in fundamental conceptual and theoretical differences in published work (Bolam & McMahon, 2004). Kelchtermans (2004) comments on the difficulties in PD literature when often key words and terms have conceptually different meanings for the researchers which make it difficult to develop a *‘solid overarching research-base that can be used to construct practice for CPD (p218);’* this is described by Bolam and McMahon (2004) as *‘conceptual pluralism (p52).’*

There have been attempts by academics in this field to categorise published work on PD in terms of different outcomes (Harland & Kinder, 1997, Guskey, 2000, Joyce & Showers, 2002, Cordingley et al., 2005b), orientation of the CPD -individual versus collaborative- (Cordingley et al., 2005a), models of evaluation (Guskey, 2000, Templin & Bombaugh, 2005) characteristics of CPD models in terms of delivery and purpose (Kennedy, 2005).

The EPPI Centre (Evidence for Policy and Practice Information and Co-ordinating Centre)<sup>23</sup> CPD Review Group conducted and produced four substantive reviews between 2003 and 2007. The systematic review process involved a standard method where the findings of different pieces of primary research were used to help answer agreed research

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<sup>23</sup>EPPI centre is part of the Social Science Research Unit at the Institute of Education, London,

questions. The use of inclusion criteria<sup>24</sup> was an essential part of the selection process once studies had been identified through a systematic search strategy.

The aim of the first review (Cordingley et al., 2003) was to review literature on sustained collaborative CPD in terms of how it affects teaching and learning, including its impact. Of the fifteen studies that met all the selection criteria all but one linked collaborative practice with improved teaching and learning. The outcomes of the research of the different studies fitted into four broad categories – *teachers, students, CPD processes and the research itself* (p 4). Whilst changes to teachers and students were considered on both behavioural and attitudinal levels, studies that commented on CPD processes tended to report on either the outcomes or the actual processes involved, but not both.

The second review used some of the studies of the first with a focus on finding new studies which were individually-orientated CPD programmes so that comparative data could be obtained with collaborative CPD studies (Cordingley et al., 2005a). Through the selection process for appropriate studies, of the twenty-six studies that were initially chosen as individually-orientated, only three made it through the in-depth review process compared with fourteen that were identified as collaboratively based. This gave evidence for the emphasis of CPD research being carried out through collaborative means; this was partly due to the imbalance in the number of available studies for each focus, but also

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<sup>24</sup> For example in the first review, of the fifteen different criteria used, seven were used for the initial selection and eight for the in-depth review. Criteria that were used included: measure of impact, time, age of students, detailed description of method and data analysis and reliability and validity checks.

because the outcomes of the individually-oriented studies showed comparatively weak evidence for sustained changes to teachers and students (p 5).

The third review focused on the methodological considerations of the outcomes of CPD research, which they separated into teacher-only outcomes compared with teacher and student outcomes (Cordingley et al., 2005b). Of the forty-five studies that were used, thirty-one of them had been used in one or both of the previous reviews. They were all compared through the following foci: *aims, nature of the interventions, outcomes and study design*. Whilst a clear distinction was found in the aims and findings because of the different emphasis on teacher, or teacher combined with student, outcomes, all of the study designs were evaluative, being researcher based. One of the most pertinent findings to the RBT was the clear difference in the nature of the interventions in terms of the emphasis given in the research literature to teaching and learning compared with CPD processes: *'The review found that studies which focused their aims on both teacher and student outcomes were more likely to have rooted their interventions in evidence about pedagogy. Conversely, studies which focused their aims on teacher impact were more likely to have been rooted in the literature about CPD and adult learning. CPD providers and CPD school leaders may wish to ensure that CPD programmes draw explicitly on both the relevant public knowledge bases about teaching and learning and about CPD (p 12).'* (Cordingley et al., 2005b)

This finding is very important for the RBT and is considered in the methodology in terms of the type of the data that is to be collected. It also helps to highlight the need for a

detailed analysis of the theoretical basis of the CASE scheme and the context of CASE compared with other interventional programmes as the RBT intends to explore CPD in the context of the pedagogy of CASE.

A fourth review (Cordingley et al., 2007) looked at the role of the specialist within CPD. The findings of this review are important in terms of key characteristics of PD which involve a specialist, as this is the current CASE model. Twenty-two studies made it through the systematic selection process. An in-depth analysis was carried out to elicit some of the underlying themes and practices that led to the reported positive outcomes. The types of PD inputs that specialists used were: *modelling, workshops, observation, feedback, coaching and planned and informal meetings for discussion* (p 12). An important finding for the RBT was the dual nature of the PD input in terms of new knowledge and support and that for CPD to be successful: *'it was important to pay as much attention to the process, teacher learning and their needs, as to the delivery of new knowledge* (p16).' This is drawn upon in Section IV in terms of differentiating between research tools and PD inputs.

In terms of the strengths and limitations of the systematic review process, the first review asserted that a degree of parity was achieved in terms of the studies that made it through the selection process; this added substance to the comparisons that were drawn, because of the rigorous application of selecting and then applying an in-depth analysis to studies, including consideration of the weight of evidence. They were aware of the limitations of the studies in terms of the data, which included lack of explicit information about core



terms and processes and the appropriateness of the research design to assess the effects of collaborative practice. In addition, they acknowledged two biases: too many studies being focused on the curriculum areas of ICT, Mathematics and Science; too many studies being based solely in the USA.

The relevance of the CASE PD programme to these reviews relates, in part, to longevity as all the studies used in the reviews involved teachers being involved with their respective programmes for a minimum of three months and that the last review focused on the role of specialists in CPD. In addition, they helped to unpack and, therefore, give clarity to some of the terminology, processes, and types of outcomes of PD programmes as well as weaknesses of research, especially in relation to methodological considerations.

The literature review draws upon some of the main findings and recommendations of the reviews. Part I considers PD models which describe how teachers change and Part II links the CASE team's approach to CPD to established literature. Parts III and IV consider evidence relating to teachers' PD with CA schemes and student outcomes respectively. The review is therefore separated into the following parts:

- Review of PD models
- CASE CPD and PD literature
- Effects of the CASE approach to CPD
- CASE project – student outcomes
- Overall summary

Individual studies that are expanded upon are shown, in general, to be relevant either through their focus on secondary education, intervention approaches, novice to expert, constructivism in terms of learning or Science as a curriculum area.

## ***Part I: Models of PD - Teacher Change and Teacher Learning***

*'models of teacher development are stronger on description than on explanation. ...This is a significant deficit for those interested in teacher education because programmes need to be based on an understanding of the mechanism of change rather than the milestones (p388).'* (Desforges, 1995)

This quotation is central to the RBT in that it highlights one of the major issues of research into PD of teachers - there has been a plenitude of research in the 1980s and 1990s that describes national, whole school, and individual factors that influence the effectiveness of PD programmes, but there is very little documented on the actual process of change for individual teachers (Guskey, 1986). More recently, EPPI centre reviews (Cordingley et al., 2003, 2005a and 2005b), on CPD primary research, found that studies who reported that PD programmes had been successful, which relates to Desforges' milestones, gave very little detail about the actual CPD processes. Whilst the RBT aims primarily to understand the process of change that teachers undergo through their involvement in CASE, it is helpful in the literature review to explore different PD models that have helped to add to the discourse on the process of teacher change.

### **PD Models**

Established researchers in the field of PD have added to the theoretical underpinnings of the process of teacher change by constructing models that connect the factors involved in the change process. By their very nature, these models try to give some degree of predictability, regarding the process of teacher change and range from primary pieces of

research (Bell & Gilbert, 1996, Harland & Kinder, 1997) to some that have drawn on several pieces of evidence to construct their model (Guskey, 1986, Berliner, 1988, Mevarech, 1995, Clarke & Hollingsworth, 2002).

Guskey (1986) proposed an ‘alternative’ model which suggested a process for PD where the three outcomes occurred in the order of: *teachers’ classroom practice, students’ learning outcomes and teachers’ beliefs and attitudes* (p7). He posited that teachers need to see changes in their students’ achievements because of alterations in their teaching practice before they change their attitudes and beliefs. Whilst his article cited several pieces of evidence to support this alternative model, there was little expansion of the constructs in the model. Guskey did acknowledge, however, that due to the nature of the cited evidence there were difficulties in generalising from such a model. In addition, there was no consideration given to the diversity of sources, and types of analysis, which puts into question the validity of his model, especially in terms of the inherently implied causality between the four domains. Guskey did recognise, however, that there must be a degree of a reciprocal relationship between the three outcomes of teacher PD, advocating that more research was needed into the process, especially the connections between these outcomes. In a more recent publication (Guskey, 2000) acknowledges that this model simplifies a complex process and that the process of change is cyclical rather than linear in nature. In relation to the EPPI centre review, Guskey’s model would be an example of research that focuses solely on outcomes rather than considering CPD processes as well.

In Berliner's (1988) model of professional growth, based on novice to expert literature from a range of disciplines, there are five stages –*novice, advanced beginner, competent, proficient, expert* (p2). The novice stage describes practitioners as inflexible, requiring concentration to perform tasks which are, therefore, consciously determined. The expert stage is described as having: '*an intuitive grasp of situations and seem to sense in non-analytic, non-deliberative ways the appropriate response to make* (p5).' The main inference from this stage model is that as teachers gain experience and become more effective in their practice, their progression reflects a change from actions being controlled consciously to unconsciously; this allows their actions to be more fluid, in part, through quicker response times. Berliner (1986) suggests that rapid responses are based on recall skills which: '*appear to act like schema instantiations. The recognition of patterns reduces the cognitive processing load for a person* (p11).'

The stage model is based on a range of empirical evidence on novice/expert literature; several studies were expanded upon to support the stage model, but they were all comparative in nature in terms of the differences between novices and experts rather than studies which have looked at the actual development process. Whilst it is suggested that progression through the stages can take up to five years, Berliner (1988) advocates that focus should be given to whether the stages make sense rather than the time it takes for change to occur. In addition, he supports the premise that teachers can be at different stages depending on the context. Whilst this model is built upon generic research into the development of expertise (Dreyfus & Dreyfus, 1986) across a range of professions and is very detailed in terms of classroom practice, the comparative evidence base focuses on

the differences of teachers rather than progression; it therefore is subject to the same criticisms by Desforges and the EPPI centre in terms of description on stage-based outcomes rather than any explanation of process.

Based upon two pieces of research, Mevarech (1995) outlined a U-curve model of professional growth whose shape related to the positive and negative aspects of the process of change of teachers' pedagogical beliefs, attitudes and perceptions. The model proposes five stages: *survival, exploration and bridging, adaptation, conceptual change and invention* (p154). The stages show a continuous progression as opposed to development through discrete phases. The initial survival stage relates to the previously discussed PD literature on barriers to change which was described by Joyce and Showers (2002) as the initial transfer problem. In addition, it relates to Leat's (1999) construct of craft knowledge which encompasses the development of expert knowledge where "*each new context requires a different assemblage of craft knowledge*" (p394), which equates to experienced teachers being a novice practitioner of a new classroom methodology.

On one level, it could be suggested that Mevarech was proposing a model that gave some explanation of the actual experiences of teachers as they embarked on a programme of change with an innovation that required a shift in their pedagogy of how students learn. In the survival stage, teachers experience being novices again which is characterised by a technical process where teachers are quite mechanistic in the way they use the new materials of the programme. Mevarech (1995), however, states that this model rejects the

linear progression of novice to expert which has become the established assumption in the field of novice-expert within PD, citing Dreyfus and Dreyfus (1986).

The next phase is characterised by a movement to a more positive approach as teachers explore and bridge the techniques, but the process is still quite technical and teacher-centred. The *adaptation phase* is seen as a movement from technical application to reflective implementation, which is student-centred and collaborative in terms of teachers being more willing to share their ideas with others. In addition, this phase supports Guskey's proposition that teachers' beliefs and perceptions change because of changes in their students' performance. The penultimate stage is conceptual when the teachers alter their pedagogical knowledge of how students learn and are prepared to share and question more with colleagues and are keen to develop more knowledge about the programme. The *conceptual stage* may be followed by an *invention stage* where teachers experiment with their new pedagogical knowledge, which equates to Adey and Shayer's description of a teacher's ownership of the methodology.

Whilst this model clearly differs from Berliner's linear model as it incorporates the negative and positive aspects of the process of change, there are several similarities, especially regarding classroom practice and five stages of development. It deals with the separation of beliefs and attitudes and pedagogical knowledge, but could have been more explicit about alterations in practice beyond technical to reflective. Unlike the previous two, it does give a detailed account of the theoretical background in terms of the process of change; this has been discussed in Section II in terms of teachers' development

through a constructivist view of learning, which includes terms such as '*interference*' '*conflict resolution*' and '*mutual reasoning*'. It also recognised that contextual and individual factors had been ignored and therefore gave some discussion to support, and feedback to bring about, professional growth.

As it is based on two pieces of primary research, Mevarech's model is open to the same criticisms as Berliner and Guskey's in terms of the methodological considerations of different studies being used to support a model. In addition, neither author, through the elaboration of his/her respective model, cited any conflicting research or theoretical perspectives. These models, through whichever path, both implicitly suggest that change is a gradual process; of the three, Mevarech's model gives a framework which encompasses both attitudinal and behavioural changes that individuals may experience over time as well as a clear position on CPD processes.

The next two models have been selected as they are all based on primary research carried out to support the formulated model.

A commonly cited model of teacher development was devised by Bell and Gilbert (1996) based on the evidence of a three year piece of research in Science teachers' PD in New Zealand<sup>25</sup>. The findings of this research are extremely pertinent to the RBT because it involved teachers being challenged to change their teaching from an instructional approach to a constructivist one which allowed students to develop conceptually. The

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<sup>25</sup> The Learning in Science Project was carried out at the University of Waikato and was funded by the New Zealand Ministry of Education (Bell, 1993). Forty eight teachers volunteered to be part of the programme which involved two hour weekly meetings after school.



proposed model, developed through the empirical evidence of the project<sup>26</sup>, categorised teachers' development or learning into three domains– *social, personal and professional*.

This model is not constructed as a stage-based one with respect to time, but rather as having a loose and flexible progression within the three components for each teacher. The three domains can be seen as aspects of teachers' PD which the authors advocate is better described as teachers' learning (Fullan & Hargreaves, 1992). The three components are not dependent on one another, but most certainly interact to bring about the developmental process. Again within this model there are similarities to constructs mentioned by others researchers, but again no indication of how they relate to students' achievements.

Central to this research is a collaborative approach to CPD which supports the findings of the second EPPI centre review in terms of the effectiveness of collaboration compared with individually-focused PD. A pertinent finding to the RBT was the use of anecdotes by teachers during the training sessions (Bell, 1994). It was established that teachers used anecdotes to note significant episodes, share achievements, add to the debate about theoretical notions and to problem-solve particular issues. In addition, it was found that rather than the discussion being cyclical, once one teacher had told an anecdote, then the dialogue went back and forth between the other teachers and the anecdote-teller. The purpose of anecdote telling was analysed in terms of cognitive outcomes like accepting

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<sup>26</sup> The research was mainly qualitative with multiple data collection techniques used including interviews, questionnaires and classroom observations.

new theoretical ideas as well as personal and affective outcomes which linked to belief and value systems.

The clear distinction of this model from Guskey (1986) is the fluid nature of the learning process for teachers as they embark and progress with a new initiative in terms of the interactive and interdependent nature of the three domains involved in the process of change for teachers. In addition, unlike the previous three models which were based on more than one piece of research, with differing methodological and procedural considerations, this was based on a single longitudinal piece of research which was clearly not trying to advocate any causal relationships between PD programmes, teacher practice and student outcomes. It supports the proposition that individuals respond differently to change through the personal domain as teachers experience professional changes through their teaching practice and social changes through working with others.

The recurrent theme of how individuals respond differently to the same in-service programme was highlighted again by Harland and Kinder (1997)<sup>27</sup> based on their research of a longitudinal study of the PD of Science teachers in primary schools. Initially when looking at outcomes, forty-four types of observed impact were measured and these were divided into nine broad categories to form a typology of INSET outcomes. These nine outcomes were then tentatively separated into a hierarchy based on the qualitative data of teacher accounts and lesson observations. From lowest to highest

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<sup>27</sup> The paper was based on the finding of a longitudinal study which looked at a programme of staff development concerned with Science in primary schools. It was funded by Calderdale, LEA, and the National Foundation for Educational Research and studied the impact of various CPD activities on teachers in five case study schools, over a three to four year period, through lesson observations and interviews.

the nine were ranked third order: *provisionary, information, new awareness*; second order: *motivation, affective, institutional*; first order: *value congruence, knowledge and skills* – with the ultimate goal of PD- *impact on practice*. The nine outcomes were then applied to individual outcome routes using the analysis of qualitative data of two different participant teachers. The hierarchy was essentially inductively derived by looking at the different outcomes and how they related to changes in practice. The analysis of the teachers' outcome routes helped to formulate the hierarchy and at the same time gave support for the individual nature of PD.

The juxtaposition of this model with some of the previous ones indicates that rather than delineating the relationships between the outcomes, it posits that impact on teacher practice is the ultimate reason for PD; therefore, if teachers only develop third order outcomes, like an awareness of the new approach and use of the new materials, then the effect of these outcomes will not be equated with sustainable change to practice. A relationship between the outcomes is suggested in that changes in one could promote changes in another, but not through any kind of linear progression. It is interesting that student outcomes were never mentioned which again supports the findings of the EPPI centre reviews in that there was no mention in the literature of the pedagogy being employed by the teachers in this in-service programme because only teacher outcomes were studied not teacher and student ones.

The final and most recent model, Clarke and Hollingsworth (2002), is based on Guskey's (1986) model which therefore gives an example about the development of the model in

terms of the four domains and connections between them. The interconnected model used the results of three Australian studies<sup>28</sup> to explicate the non-linear model which had the four domains of: *external domain - source of information or stimulus, domain of practice – professional experimentation, personal domain- knowledge, beliefs and attitudes, domain of consequence – salient outcomes* (p951).

It is suggested that change in one domain can be translated into changes in another through the mediating processes of reflection and enactment. Enactment is when teachers experiment with a new idea rather than just simply acting it out. Through discussion of the different mediating processes, this model does give some consideration to teachers' learning, but the position is not made explicit. The fluid nature of this model, proposing change as the professional growth of teachers, which relates to long lasting changes, certainly supports Guskey's (1986) suggestion that there would be a reciprocal relationship between the outcomes. This builds upon a review of PD (Timperley et al., 2007<sup>29</sup>) that stated that teachers' learning is cyclical, with teachers needing multiple opportunities to take in new information and experiment with it in the classroom.

In summary, this section has helped to illustrate the complexities involved in trying to formulate models of professional development, especially in terms of how to characterise progression - linear or cyclical; the inferences of causal relationships and the connections made between diverse pieces of research. An important theme of individual differences

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<sup>28</sup> The three Australian studies all involved either Clarke or Hollingsworth in the 1990s and all involved mathematics.

<sup>29</sup> This review was produced by the IAE (International Academy of Education) in conjunction with the BES (New Zealand Ministry of Education Iterative Best Evidence Synthesis (BES) Programme) looking at 97 studies of PD which had led to positive student outcomes.

has been identified through some of the models as well as the nature of, and barriers to, the process of change. The findings of the EPPI centre reviews have helped to consider each model on a methodological level as well as highlighting the predominant focus on teacher outcomes as opposed to CPD processes and student outcomes. Mevarech's model is the only one that is explicit about how teachers learn as part of a PD programme, which involves significant changes to their classroom practice.

## ***Part II: CASE CPD and PD Literature***

This part considers the CASE CPD approach outlined in Section II in relation to existing research and literature on PD, most notably the PD models discussed in the last part as well as recurring overarching constructs and processes.

### **PD Models**

Of the models discussed in Part I, Mevarech's (1995) U-curve model has been identified as aligned to the CASE CPD in terms of its similar explanation of the process of change, including a constructivist view to teachers' learning. Clarke and Hollingsworth's (2002) model emphasises the need to consider the process in terms of mediating processes, which has been part of the established CASE approach in relation to experimentation and reflection. Their model did not, however, indicate the role of a specialist, which is integral to the CASE approach especially in-service workshops and coaching visits. Berliner's (1988) model, which describes novice to expert stage development in terms of classroom practice, relates to Adey's (2004) position on the development of intuitive processes that characterise a proficient practitioner. Guskey (1986) and Harland and Kinder's (1997) models refer to individual differences such as teachers' pre-conceptions, which Guskey argues only change when teachers experience firsthand the response of students to the new approach. This relates to why the CASE team advocate both in-service and school visits, including lesson observations, so that teachers have multiple opportunities to learn and develop, supporting a cyclical nature to teachers' PD.

## **Learning and Development**

Learning and development have been clearly defined and conceptualised, including how they are inextricably linked, by Adey and Shayer (1994) based on Piagetian stages of development and Vygotskian ‘spontaneous’ and ‘non-spontaneous’ thinking (Shayer, 2002). As suggested by Fullan and Hargreaves (1992) and Bell and Gilbert (1996) the PD of teachers is equivalent to teachers’ learning throughout the change process. Both McGuinness (1999) and Leat (1999), in their respective reviews of thinking skills programmes, found that, in general, they were all constructivist in origin in terms of the process by which students learn and/or develop. Interestingly, neither of these reviews commented on applying constructivism in terms of students’ learning to the process by which teachers learn and develop. The CASE team’s approach to CPD, however, has been explicit about teachers’ PD in terms of a learning process based on constructivism through ‘active’ mediating factors; this would support positions like Clarke and Hollingsworth (2002) who have described teacher change in terms of a shift in agency from one- off training days to ‘life-long’ learning, coining the expression of ‘professional growth’ which occurs because of professional learning.

## **Teachers’ Knowledge**

Pedagogical content knowledge (PCK) was identified by Leat (1999) as an important individual construct that needs to be considered when implementing thinking skills programmes. In the original description given by Shulman (1986, 1987) there are several elements of PCK which link to the CASE pedagogy, including students’ preconceptions and the conceptual difficulty of specific concepts. The CASE pedagogy originated partly

from the taxonomies used by Shayer and Adey (1981) in their application of the reasoning patterns<sup>30</sup> to scientific concepts. It shifted the focus from the actual content being delivered to the reasoning patterns that underpin the concepts being taught through the given contexts. Through the cognitive activities -pillars of CASE- students can develop their generic reasoning patterns through a scientific context. Teachers, therefore, firstly require the general pedagogical knowledge of the reasoning patterns; secondly teachers need the PCK to be able to use the scientific contexts to allow the reasoning patterns to be developed by their students. This highlights the importance between knowledge of the CASE pedagogy and how it connects with the methodology, including classroom practice.

When elaborating on PCK, Leat (1999) notes that one of the dangers of the CASE materials coming as a complete package is that teachers can think that they can just follow the lesson plan without giving careful consideration to the implementation and changes to the classroom environment; this resonates with the findings of Jones and Gott (1988)<sup>31</sup> through their work with teachers implementing the CASE scheme in Sunderland. In relating this position to the stage-based PD models, the initial stages are characterised by a mechanical use of the methodology, where adaptations are made once teachers have developed the episodic knowledge of the resources and activities; this would support Adey's position as to why teachers' adoption of the methodology is a slow process.

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<sup>30</sup> Reasoning patterns or schemata are the Piagetian structures of formal operational thinking.

<sup>31</sup> The research will be discussed in the part of the review that evaluates the CASE project.



The complexities involved in trying to link teachers' knowledge and beliefs to their practice has very much been a central facet of the PD models addressed earlier in the literature review. Eraut (1994) emphasises the reciprocal relationship between theory and practice, advocating an interpretation mode of knowledge-use as opposed to a replication or application mode. The traditional approach of learning theory and then using the knowledge in practice suggests that theory and practice are two discrete processes; this Eraut suggests has been the prevailing view of learning in education with teacher INSET being based on this perspective. Eraut posits it should actually be seen as one process and that more consideration should be given to practical knowledge, where: '*nothing is valid until one has tried it and, by implication, adapted it for oneself* (p32).' This traditional model of theory, then practice, can be related to the transmission PD model (Fraser et al., 2007) with a transformative process being aligned with the CASE approach which recognises the reciprocal relationship between theory and practice and relates to teacher ownership.

In relation to the development of teachers' knowledge, Fraser et al (2007) suggest, an inconsistency between the importance Adey places on intuition and the belief of measurable teacher outcomes to evaluate CPD, stating that: '*there seems to be a lack of congruence between the notion of pedagogical skill as internal and intuitive and measuring its success or effectiveness by external means* (p164).' This very much relates to Cordingley's (2008) position that much has been written in the PD literature about tacit or implicit knowledge, but, using recent research on Assessment for Learning (Marshall & Drummond, 2006), teachers need to be given support to make their existing knowledge

and practice explicit, so that they can then make comparison with a new approach. This would fit the CASE team's approach through the use of activities during in-service sessions and in-school coaching visits, including a range of 'active' mediating processes. Adey's conceptual change model is based on the connections between concept change, reflection and intuition; therefore, the answer to the implied lack of congruence lies possibly in the metacognitive part of teachers' development where they reflect on their knowledge and behaviour, trying to make any implicit processes explicit through reflection. This may not always be successful, but at least the question has been consciously raised which makes it available for consideration at another time. This is very much the process of cognitive development, which does not advocate immediate success through learners' engagement in the different cognitive processes, but rather a long-term view of development.

In relation to intuition, Berliner (1988) and Adey (2004) have supported the premise that intuition is part of the repertoire of an expert practitioner. Therefore in relating this back to the change process and teachers developing a sense of ownership, it suggests that the transition involves a shift from explicit to implicit actions as the methodology becomes established in teachers' schemata; this change is then evident in the intuitive nature of their actions in the classroom, in part, through quick and fluid responses. Adey (2004) makes the point that intuitive should not be confused with instinctive as the latter would suggest some innate component; Adey makes it clear that intuitive behaviour: '*occurs without explicit cognition at the moment at which it arises* (p15).'

## Teacher Ownership and Individual Differences

In Sections I and II, the construct of teachers developing a sense of ownership of the CASE methodology was central to the CASE team's approach to teachers' PD. In the Enhancing the Quality of Argument in School Science (EQUASS) project (Osborne, Erduran & Simon, 2004a), teacher ownership involved teachers devising lessons based on a theoretical framework of argumentation. Simon, Erduran and Osborne (2006), in one of the papers on the primary research, looked at teachers' PD by analysing the changes in five teachers<sup>32</sup>, over two years, in terms of their approach in the classroom; they found that rather than a marked change in their individual approaches that the greatest differences were actually found between individual teachers in that: *'teachers implement new ideas differently and so there are no homogeneous outcomes... If professional development is to impact on practice, such differences need to be recognised and taken into account when designing professional development for teachers (p256).'* The importance of recognising individual differences has been previously mentioned especially teachers' pre-conceptions (Adey, 2004) and has been incorporated into several of the models discussed in Part II.

These sentiments are very much echoed by Hargreaves (1995) whose position, underpinned by a postmodernist perspective, recognises the complexities and uncertainties of our professional and personal lives as we become an increasingly post-rational society. This poses the question of whether there is a dichotomy between a clear rational generalised approach to PD compared with one that incorporates and values individual differences. Hargreaves' position clearly advocates a discourse in PD that

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<sup>32</sup> I was one of the teachers involved in both years of the project

allows programmes to encourage individual flair and passion, which is very much echoed by Day and Sachs (2004). This could be interpreted as situated and/or social researchers suggesting that the cognitive approach is too mechanistic in its approach to PD (Anderson et al., 1997). Adey and Shayer (1994), however, from their cognitive perspective, clearly recognise and value individual differences when considering teachers developing their ownership of the methodology: *'Until one has made a method one's own, with one's own idiosyncratic interpretation and colouring by personality and the particular school environment, it will remain an 'add-on' skill which is easily lost when the external stimulus of the INSET programme or research project is removed (p157).'*

To conclude, in relating the CASE approach to CPD to existing literature, the PD models that consider the development of teachers' knowledge, beliefs and classroom practice through a constructivist view of learning are compatible with the tenets of the founders of the CASE project, who advocate an active and transformative process. These models have the benefit of giving an explicit structure to the process which is based on a transfer of the methodology from specialists to teachers. Central to the CASE PD process is teachers' pre-conceptions, where conceptual changes involve the re-construction of new knowledge, which can be considered on both a pedagogical and methodological level. This is why CASE, like other PD programmes, has to consider individual differences between teachers and how they can support and/or hinder the implementation of innovative classroom methodologies.

### ***Part III: Research into the Effects of the CASE Approach to CPD***

This part considers empirical evidence in relation to teachers' PD with CA schemes; it is separated into research conducted to support the development of Adey's (2004) implementation model and CA research which has focused on various aspects of teachers' PD.

#### **Implementation Model**

Adey (2004), based on PD literature on school and individual factors, applied pertinent findings to CASE to construct a basic implementation model; it contained the school variables of *senior management involvement* and *communication within the Science department* as well as the teacher variables of *level of use*, *sense of ownership* and *understanding of theoretical basis*. Two separate studies were conducted with cohorts of schools that had finished the two-year King's INSET programme ( first cohort 1991-1993, fourth cohort 1994-1996), using broadly the same research tools. Based on correlation analysis, the results helped to develop the implementation model in terms of connections between different school and teacher constructs as well as student outcomes. Most relevant to the RBT was the positive correlation between teachers' sense of ownership and internalisation of theory<sup>33</sup>; Adey (2004) connects these findings to teachers' ability to adapt and invent lessons, which he states would not be possible without the attention given during INSET to unpacking the psychological models that underpin the project.

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<sup>33</sup> Both constructs were measured by teacher questionnaires.

It is worth noting that since the establishment of the two year INSET programme at King's College, London, well over three hundred schools have participated, with the first cohort beginning in 1991 and the last in 2002 (Adey, 2004). Research was carried out during 1997-1998, through interviews with teachers at the schools (Adey, 2004), to explore the long term issues of keeping CASE 'alive' in schools once the INSET programme was over. It was clear that Science departments that had the interest and backing of their senior leaders, and were able to foster collaborative practice, were the most successful. In terms of long-term maintenance, the need to have established structures in place in schools was found to be important, including a formal system for inducting new teachers to the methodology.

Whilst both pieces of research allowed researchers retrospectively to elucidate factors that were involved in the successful/unsuccessful implementation of the scheme in a variety of schools, it did not elicit the learning process of individual teachers, which is the primary focus of the RBT.

### **Teacher-focused Research**

This sub-part concentrates on different studies that have focused on teachers' PD with different CA projects.

- **CASE and CAME Case studies – Secondary**

The research of Landau (2004) looked closely at the PD of teachers within a school context with both the CASE and CAME schemes in four schools<sup>34</sup>. The study gathered data through observations of lessons and INSET sessions as well as interviews with teachers where Landau was a non-participant researcher. The premise of the research was that the effectiveness of PD would be influenced by teachers' personalities and beliefs (positive and negative) and the school's ethos (supportive and unsupportive).

Landau looked at progression, in part, through observing both CA and curriculum lessons; she found that the two were linked in terms of development especially teachers' questioning techniques. Whilst the case studies gave a rich set of data, there appears to be an inconsistency in her methodology in terms of the use of a hypothesis combined with an inductive approach to data analysis, where constructs were not defined in advance. In addition, Landau had little experience of CA which she stated allowed her to maintain a non-threatening position; it does, however, make her observations questionable in terms of the CASE methodology where she stated her field notes enabled her to get a 'feel' for each teacher's technique and she was therefore able to judge progression.

In terms of the main findings, individual teachers' case studies highlighted the importance of the school context and how easily innovation can fail because of a lack of leadership support. Conversely, it did show that a teacher can be in a supportive environment, but can be resistant to change which therefore supported the original

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<sup>34</sup> The research was carried over a two year period and initially involved working with fifteen teachers with three teachers' case studies being expanded upon in detail.

hypothesis that both school ethos and teachers' beliefs affect PD programmes. The rationale given for the findings was because change depends on individuals, both teachers and leaders, who respond to change differently; this relates to previous discussion on the importance of considering individual differences in PD programmes. The study also found that teachers started to use the methodology in their normal lessons, supporting Adey and Shayer's position about the transfer of ownership of the methodology. Adey concludes that: '*All these stories illustrate the fact that real change is a slow process* (p118).'

- **CA KS 1**

Through an evaluation of the CA@KS 1 – Let's Think- scheme, Hewitt and Hewitt (2004) looked at the systemic PD programme in terms of viability and sustainability. The PD programme followed a very similar approach to the CASE team's. The qualitative data was obtained through interviews and written evaluations which focused on the perceptions of teachers, teacher-tutors, headteachers and local authority inspectors.

From the wealth of findings, the most pertinent to the RBT relates to the six teacher-tutors who had completed the programme the previous year and were following a tutors' PD programme so they could support new teachers to the scheme. The findings were that the teacher-tutors struggled at the start of the year with being seen as 'experts' especially because of factors such as age difference and teaching experience. As the year progressed, however, they felt they had made a difference to the PD of the teachers they had been working with and saw their role as practitioner tutors, which involved being



both supportive and instructional. In addition, the teacher-tutors placed great emphasis on making sure that their values and beliefs were congruent with those of the teachers that they were coaching and that establishing a group identity and a common set of ideals were essential for INSET sessions to be effective teachers.

The teachers overall were very positive about the CA programme; an interesting finding was how many were surprised at students' responses to the lesson, especially those students who were unexpectedly more engaged in the lessons such as those with poor literacy skills.

The findings of this research supported many aspects of Adey's (2004) implementation model, but the focus on the teacher-tutors added another important area of consideration, especially regarding a pragmatic approach to the maintenance and longevity of CA schemes.

- **CAME – Primary**

Hodgen (2002) studied the use of reflection when working with teachers on the primary CAME<sup>35</sup> project in terms of how it was used to transform their mathematical knowledge. The research involved six primary school teachers delivering the initial four lessons provided by the researchers and then working fortnightly with the researchers to devise new lessons. In the second year of the research, they followed the same pattern as the CA KS 1 Science scheme with the second year teachers becoming tutors to the new cohort of

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<sup>35</sup> The research involved a three year longitudinal study. Qualitative data was collected through lesson observation and analysed to look for progression.

teachers. Case studies of two of the teachers mainly based on interview data showed that whilst in the initial phase, reflection did not initially cause any significant changes in knowledge, it was suggested that it laid the foundation for future reflection. In addition, a critical factor for overcoming barriers related to teachers being able to reflect from an outsider's position. The main conclusion was about the role of reflection in changing tacit knowledge into explicit forms: *'the transformation of these two teachers' intuitive, implicit and everyday knowledge into explicitly mathematical understanding was considerable (p130).'* Hodgen (2002) did concede that the teachers' circumstances were highly unusual in terms of the intensity of the programme and their close working with the researchers; this approach would support the educational debate about the direct involvement of teachers in research (Stenhouse, 1975, Hopkins, 2002).

- **Thinking Skills Programme, including CASE**

Leat (1999), drawing on a range of sources, including his own research, focused on the difficulty of implementing thinking skills programmes, using CASE as one of the main examples, and equated this to- *rolling a stone up a hill*. The paper focused on the individual teacher and the constructs that were deemed important to PD of teachers within thinking skills programmes which were identified as: *socialisation, craft knowledge and expert-novice, pedagogical content knowledge, images of teaching and teaching and the Emotions*.

Teacher accounts were used as qualitative data to support the relevance of each construct to implementing thinking skills programmes with teachers' experiences in delivering

CASE being drawn upon for nearly every construct. For example, when expanding upon craft knowledge, which was discussed in the last part, a CASE teacher's narrative was used: *'When you are working with groups you have to learn to be one of them, you need a good relationship, so that you can encourage them to put down what they think and they have to stand up for what they think (p395).'*

By relating it to Adey (2004) and Landau's (2004) findings on teachers' PD with CA, the craft knowledge being illustrated by Leat seems to relate to the need for teachers to change their role and relationship with students; through this alteration in their knowledge, teachers can facilitate the lesson's cognitive aims, in part, through a shift in emphasis, especially through student-centred discussion. In addition, it relates to teachers' knowledge of the methodology, which Leat separates from PCK.

As already mentioned, Leat links craft knowledge to the novice/expert divide, citing several examples of different thinking skills programmes where the teachers cannot use their 'expert' craft knowledge as the methodology is so different to their normal practice; therefore they become a 'novice' again which has previously been highlighted as one of the initial barriers to, and thus reasons, why PD programmes can end up not being successful (Joyce & Shower, 1988). The application of the CASE project to the development of a teacher from novice to expert is a recurring theme throughout this section.

- **Secondary CASE**

Jones & Gott (1998) published the findings of research born out of Jones' experience as a CASE trainer in Sunderland working with five schools<sup>36</sup>. The naturalistic setting of the research meant that there were major differences between schools in terms of set-up and implementation. Data was collected on student outcomes, which will be expanded upon in the next part. In relation to teachers' PD, a questionnaire was completed by teachers who had been involved in the scheme. The report gave a detailed description of each school and summarised the teachers' responses to the PD programme. Overall the responses were seen as favourable towards CASE, especially in terms of students benefitting from the CASE project and most teachers responded that they had used the methodology in other Science lessons. Problematic areas, however, were also identified most notably preparation time, resources and language.

As future recommendations, Jones & Gott made the suggestion that there could be a link between the CASE programme and the procedural knowledge base of the Science National Curriculum; they reported that the majority of teachers had made an explicit connection between some of the CASE activities and investigative work, without expanding on the nature of evidence. They posited that the CASE programme could be fragmented to allow teachers to be more flexible, essentially giving more support to instruction-based teaching.

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<sup>36</sup> Jones was part of the first PD programme for trainers which started in 1991 in conjunction with the first cohort of schools to take part in the two-year CASE INSET programme at King's College, London (Shayer, 1999).

There are several areas that highlight major flaws in their argument in terms of their lack of congruence with other CA literature. Firstly, in the introduction, they describe the CASE programme as prescriptive with detailed lesson plans which should essentially be followed like a recipe. In the section on teachers' feedback, the following comment was noted 'one teacher criticised the teacher's guide as being too prescriptive, restricting the teacher (p 761)'. This shows a lack of appreciation of the methodology and the cyclical nature of the pillars within a lesson. Allowing teachers to adapt the lesson, especially in terms of bridging ideas and/or reducing the 'number-crunching' part of the lesson, is very much how teachers develop an ownership of the methodology. For example, in Landau (2004) in terms of an individual teacher's development with CASE the following was noted: '*there was evidence that Peter had adapted and extended TS 7 to explore ratios more fully...Peter managed to alter his teaching substantially during the first year, adapting and developing TS lessons by the Summer term (p 110)*'.

Secondly, the idea of linking CASE to the National Curriculum appears to have been born out of a common stance of the participating teachers that the first five lessons, regarding the control of variables, relate well to the investigative strand. This reverts to a short term view of focusing on the context rather than students' cognitive development. Finally, there was no detail given of the questionnaire statements that related to teachers suggesting the explicit connection and therefore this finding is questionable as it could have been implied by the researchers.

Shayer's (1999) response paper reiterates the pedagogy of CASE, including why linking parts of CASE to procedural knowledge requires a different level of abstraction and does not in any way relate to development of a general processor.

To conclude, research into teachers' PD with different CA programmes has highlighted that there is a clear difference between the CA methodology and 'normal' classroom practice, but that over time teachers transfer the methodology to the latter. Research has focused on both teacher and institutional constructs with a view to developing the knowledge base on how best to implement and maintain CA schemes. A commonality amongst all the studies is that the process is challenging for teachers and therefore they require a lot of PD input and support.

### ***Part IV: CASE Project - Student Outcomes***

This part summarises the findings of the primary research conducted in the 1980s and is followed by an evaluation of the results in terms of positive and critical reviews of the CASE project.

#### **Published Findings**

In 1990, Adey and Shayer published the first of four papers summarising the findings of the pilot, which consisted of eight experimental groups and one laboratory class (this was used to trial new material). When the results of the experimental groups were compared to the control classes, significant gains were reported in the mean difference between the pre- and post- Piagetian Reasoning tasks. Further differential analysis, however, highlighted the variables of gender and starting age of the students, as factors that affected the cognitive gains of the students. Significant gains were found for boys whose starting age was twelve plus (Year 8), whilst for girls some gains were shown for three of the experimental / laboratory groups where the starting age was eleven plus (Year 7) and all of these were from secondary not middle schools. The three other papers (Shayer & Adey, 1992a, 1992b and 1993) looked at the achievements of the students who participated in the research in their public examinations, GCSE (General Certificate of Secondary Education) Science, Mathematics and English respectively. The aim of this additional analysis was to see if the reported Piagetian cognitive gains could show a statistical effect on students' attainment in their GCSEs and to see if the cognitive gains had long term effects after the intervention had finished. The analysis of students' achievement showed that there were different effect sizes of  $0.67\sigma$ ,  $0.72\sigma$  and  $0.69\sigma$  for

Science, Mathematics and English respectively. The results were used to support the claim that sustainable cognitive gains (which were attributed to students' enhanced metacognition) were related to gains and achievement and, as the gains were in all three subjects, it supported the cognitive perspective of the relationship between cognitive development and a general central processor.

CASE II relates to subsequent analysis of CASE schools involved in the King's INSET programme. It did not use an experimental design as the team believed it would have been unethical to withhold the CASE project from schools based on the significant results of the original study. Instead the schools that started the King's programme in 1991 and 1994 respectively were compared with cohorts in schools who had not participated in the scheme. For every school there was clear evidence that the CASE project had added value to the students' KS 3 tests and GCSEs in English, Mathematics and Science irrespective of mean Year 7 intake (Shayer, 1999). In addition, a strange effect was found for the CASE schools in terms of the fluctuation of the mean Science GCSE grades for the 1994 cohort; the results did not rise sharply in 1999 when the students took their exams in Year 11, but gradually rose from 1997 and 1998 for students who had not participated in the scheme. Adey (2004) states that the most plausible explanation supports their earlier conjecture about the success of the original study that teachers transfer the methodology to other lessons and therefore in this case, students in other Year groups had also benefitted from the CASE methodology (Adey, 2004).



## **Evaluation of CASE – Student Outcomes**

*‘The distinctive features of CASE - strong theoretical underpinning, well-designed and contextualised materials, explicit pedagogy, teacher support and programme evaluation - provide a very strong model for successful cognitive interventions’. (McGuiness, 1999)*

Overwhelmingly the literature that cites the CASE approach does so in an extremely positive way in terms of an example of a successful intervention approach; ultimately the empirical evidence, combined with the longevity of the scheme, has led to favourable reviews which have established CASE, along with CAME, on the same level as Instrumental Enrichment (IE) (Higgins et al., 2005)

In a recent EPPI centre review (Higgins et al., 2005) on the impact of thinking skills approaches on student attainment and attitudes, including a comparative analysis with other educational interventions, twenty- nine international studies were selected to contribute to the overall meta-analysis. Four of the studies were categorised as CASE, or related, with seven studies on IE. The results of the quantitative synthesis showed that thinking skills programmes improved student performance, with effect sizes which equated to a class moving from 50<sup>th</sup> to the 26<sup>th</sup> percentile using cognitive measures.

The review did recognise the possible weaknesses of a meta- analysis from a methodological position in that the analysis is only as good as the studies that it uses. In addition, it reflected on the wide use of the term ‘thinking skills’ within educational programmes and how different these approaches can be on a classroom level. The review recommended that policy makers should promote the use of thinking skills programmes

in schools but with the following cautionary note: *‘However, as it is not clear to what extent the benefits are due to specific aspects of the programmes and their implementation or the changes in teaching and learning which ensue, it is not possible to provide precise recommendations (p 38).’* As previously mentioned, this connects with Adey and Shayer’s (1994) beliefs that the statistically significant results of the original research were in part due to changes in the teachers’ practice in their ordinary Science lessons brought about by their involvement in the project rather than solely by the CASE activities.

The published research (Adey & Shayer, 1990) showed, however, that not all students in CASE schools made cognitive gains as measured by Piagetian levels and therefore it could not be stated that all students who were involved in the CASE project were equally affected by the intervention. Desforges (1992) pointed out that the differential results, in terms of starting age and gender (outlined earlier), gave support that in maturational studies, age is only a rudimentary, proxy indicator of cognitive development. In addition, he suggested that language played a crucial part, linking it to Vygotsky and social mediation using specific scientific vocabulary and through general application.

Adey and Shayer (1993) in their paper focusing on the long-term transfer effects of the intervention of the experimental groups’ achievement in English, Mathematics and Science two and three years after the end of the intervention programme<sup>37</sup>, discussed both ‘language training’ and ‘language develops language’ as possible explanations for the

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<sup>37</sup> The greatest gains were again found with boys starting at 12+ and girls at 11+ with actually increasing effects over the period post the intervention. The strongest effects were found in girls with English and boys with Mathematics and Science.

results. 'Language training' was discounted mainly because whilst students are encouraged to discuss and agree common meanings for specific scientific concepts in CASE lessons, it is seen a subsidiary part of the underlying processes of cognitive conflict, construction and bridging. 'Language develops language' was seen as more plausible as the intervention could have enhanced linguistic skills which promoted subsequent language development. This hypothesis was rejected in favour of a general cognitive development explanation, which Adey and Shayer argued related better to the differential results of students' starting age and gender in terms of a maturational factor compared with girls having a greater inclination for language.

Interestingly, Adey and Shayer recognised that they could not explain why CASE had not worked for certain groups of students, suggesting that this '*effect can be explained in terms of learning style*<sup>38</sup> (p 26).' They conceded that this was a limitation to the study since the design, because of time and money, had not allowed any in-depth lesson observations or interviews with students. Based on the lack of detail given to this concession especially the generic use of learning styles, it did leave the door open to scrutiny of the results, including alternative explanations for the lack of cognitive gains of certain groups of students.

Leo and Galloway (1996) tried to relate the lack of parity in cognitive gains to individual differences between students which could have led to different responses in CASE lessons. As mentioned in Section I, my IFS looked at the conjecture by Leo & Galloway (1996) that the construct of students' motivational orientations could explain the

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<sup>38</sup> This has not been researched or considered beyond this initial conjecture.

differential results of the CASE primary research in terms of why no significant cognitive gains were found for some students who participated in the CASE project during 1984-1987.

Leo and Galloway proposed that the answer may lie in the domain of motivational research in that students' different motivational orientations may be responsible for how they engage in cognitive activities. In theoretical terms, they were advocating a development of the psychological and social models that underpin the CASE project to reflect students' motivational orientations. They argued that Adey and Shayer's explanations for the gender differences found, for example, girls' reliance on social skills rather than academic ones were too general and gave no explanation for the psychological processes involved. They proposed a development of the model by looking at students' strategic behaviour: *'The question of children's reasons for learning does not appear to have been considered. It is important here to understand the concept of strategic behaviour as it underpins much of Adey and Shayer's model (p 36).'*

Adey's (1996) response to this paper succinctly highlighted many of the major flaws in their argument, especially the authors' attempt to apply motivational orientations to gender and age as a means of explaining the differential results of the CASE research project (Adey & Shayer, 1990). He reiterated his and Shayer's original conjecture that the physiological changes in brain growth that occur earlier in girls was a more plausible explanation for the different cognitive gains between girls and boys. He stated that a major flaw in the construct of motivational orientation was how to operationalise it and,

therefore, measure it in individuals. He did concede, however, that he would support any research that could: *'uncover differences in different children's reactions to the CASE lessons and relate these to the cognitive gains that individuals made (p 53).'*

Adey did supervise McLellan (2006) with a longitudinal study for her PhD (2004), which was published in June 2006. The research involved approximately 1,600 students who attended nine secondary schools, five of which were delivering the CASE programme. This research looked at the relationship between students' cognitive development and their world-views- a complex construct which combined students' motivational orientations with their related beliefs on success and failure in achievement settings and their self-concept. The main findings were that students held one of six types of world-views which showed a strong degree of stability over time, but there was movement to different world-views which were separated into adaptive and maladaptive movements. Twice as many students in CASE schools changed their world-view adaptively compared to those in control school. In terms of its primary focus, the research did not find a clear relationship between any type of cognitive development and world- view, but did tentatively find some interesting results when looking at stability of world view, CASE versus control school and type of cognitive change.

Preece (1993) made a comment about some of the data analyses of the original CASE research being questionable which could have led to disingenuous conclusions. The three issues that were cited related to reported bimodality of the post-test scores for the experimental groups and the type and nature of the comparative data selected from the

control group. Shayer's response (1993) gave a clear justification for each point that was raised and welcomed the opportunity to clarify the chosen course of analysis. This dialogue certainly raises an important issue in social scientific research regarding the validity of statistical analysis and how it relates to research conclusions.

The research of Jones and Gott (1998), as discussed in the previous part, collected data on students' outcomes; each school's end of KS 3 results were used to compare students who were taught CASE lessons with those students in the same school who had not been involved in the scheme (in two schools all the students participated). Based on attainment data only, with no pre-test predictions to reflect the progress made by the students, the statistical analysis for the three schools who had comparative data, showed there was a significant difference for two schools. The authors concluded that the results did not prove that CASE works, giving no explanation as to why they had used such a crude measurement to determine progress when SRT (Science Reasoning Test) pre-test data was available.

Shayer's (1999) response finds numerous faults in their arguments, which includes the results of the Sunderland schools, using the standard value-added system through the relationship between the mean Piagetian percentile in Year 7 and percentage of level 6 and above in KS 3 Science, and repeated for Mathematics, of the five schools compared to control schools. All the differences were statistically significant; Shayer states that this analysis shows that the intervention did work and 'substantially' rather than 'not proven'.

These two papers illustrate the earlier point about issues of validity of findings based on different statistical analysis.

To conclude, the part has highlighted the success of the CASE approach in terms of gains in students' cognitive levels and attainment in public examinations. Debate has, however, centred on why not all the students made cognitive gains and the differential factors of starting age and gender.

### ***Part V: Overall Summary of Literature Review***

The process of individual teacher change, through involvement in the CASE scheme, is the primary focus of the RBT and it has been shown to be linked with a transfer of the methodology from specialists to teachers (Adey & Shayer, 1994). The EPPI centre reviews have been useful in helping to consider CPD research and PD models especially in terms of outcomes, processes and PD inputs. The CASE pedagogy has been elaborated upon to show that it is based on a balance between Piagetian and Vygotskian perspectives of cognitive development and that the methodology adopted by teachers in the classroom is not a simple process of following a detailed lesson plan (Adey & Shayer, 1994). It has been proposed that the five CASE pillars can be applied through a constructivist perspective to teachers' learning and development, and that Mevarech's (1995) U-curve model is the one most closely aligned with the CASE INSET programme.

The types of teachers' knowledge and beliefs, and how they relate to practice, have been considered in relation to the interplay between implicit and explicit processes (Hogden, 2002). The notion of an 'expert' being associated with an effective CASE practitioner has been aligned with intuitive practice; this allows teachers to be more fluid, rather than mechanical, in their approach, especially in terms of their interactions with students (Berliner, 1986, Adey, 2004). Reflection, experimentation and collaboration have been discussed as essential mediating factors to the process of teacher change, along with programme specialists (Joyce & Showers, 2002). The nature of the CASE team's approach to INSET has been considered through transformative processes which promote teacher autonomy (Fraser et al., 2007).



Finally, a wealth of literature has stated that there are problems with the process of change especially in the initial phase (Joyce & Showers, 2002, Cordingley et al., 2007), including barriers that relate to teachers' prior knowledge and beliefs (Borko & Putman, 1995, Supovitz & Turner, 2000). Constructivism as an active learning process underpins the CASE pedagogy; Adey and Shayer (1994) have also applied constructivism to the CASE PD where teachers must: '*construct the methods of cognitive intervention for themselves* (p 157).' Therefore initial barriers, which Mevarech (1995) calls 'interference', have been seen as part of the necessary cognitive conflict needed for the change process rather than a hindrance. It has also been implied that the process is gradual with teachers making slow progress (Adey, 2004).

To conclude, the literature review has helped to elicit the following important themes for consideration for the methodology:

- The primary focus for the RBT is to explore the PD process of change that teachers undergo when they try to become effective CASE practitioners; this has been aligned with moving from 'novice' to 'expert' which results in a teacher developing an ownership of the CASE methodology. The main focus is the change process, and therefore processes and their relationship to outcomes are to be explored in the next section.
- The role and importance of different mediating factors -experimentation, reflection, collaboration and coaching- have been studied in a wealth of PD literature, but not specifically in the context of CASE. These mediating factors

relate to the process of how teachers learn and develop which has been advocated through a constructivist approach where teachers are 'active' learners.

- Another consideration is how gradual is the development of teachers with the CASE methodology, including whether there are specific mediating factors that have a greater effect than others. There appears to be a contradiction when applying constructivism to teachers' PD in terms of the nature of the process of change. This is built upon Adey and Shayer's different experiences of teachers' PD with CA projects at both primary and secondary levels; they estimate that the development takes around two years, with the overall process being gradual and slow (Adey, 1993, Adey, 2004). The literature review highlights that Adey and Shayer (1994) also advocate a constructivist approach to teachers' PD with CASE. The CASE pedagogy is based on Vygotskian principles of the ZPD where cognitive development can be seen as a revolutionary process rather than a slow, incremental, evolutionary one (Shayer, 2002). Therefore if Vygotskian principles are applied to teachers' PD,<sup>39</sup> in terms of individuals' challenge and conflict as they try to develop new classroom skills and internalise the methodology, it could be argued that teachers can show 'leaps' in their development as seen through their classroom practice.

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<sup>39</sup> Whilst students' cognitive development is clearly different to teachers' PD, both involve a development process which can be considered through a constructivist approach where the emphasis is on the need to resolve cognitive conflict.

### **Section III: Methodology and Methods**

As mentioned in the introductory section, I am an accredited trainer and I have worked with teachers with of range of backgrounds. In context, this study is seen to be important as the PD programme run by King's College, London, has not existed since 2002; therefore, the findings could be helpful to schools who are trying to run the programme 'in-house' without regular external INSET as well as to schools who have struggled with the longevity of such a scheme.

This methodology and methods section is separated into the following ten parts:

- Research Questions
- Research Paradigm
- Methodology
- Selection of Methods
- Design I - Analytical Framework and Research Tools
- Design II – Time Period and Teacher Selection
- Ethical Considerations
- Methods – Procedures for Data Collection and Analysis
- PD programme
- Validity

This section shows that the research is constructed through a coherent process; the research decisions are to be justified in part through a consideration of alternatives as well as building upon the main findings of the literature review. Each part builds upon the next and begins with the identification of the research questions.

## ***Part I: Research Questions***

The research questions need to consider how teachers develop an ownership of the CASE methodology. Mediating factors have been considered extensively in the literature review in terms of promoting an active learning process. In order to formulate the research questions, it is also necessary to consider types of teacher outcomes, which could give an indication of the progress made by the use of the different mediating factors. Guskey (2000 & 2002), Joyce and Showers (2002) and the four EPPI Centre reviews are used in this part to elucidate the types of teacher data commonly found in PD studies; this is because they are all substantive publications, in terms of the broad range of PD research that they draw upon, as well as having all contributed to the main literature review.

### **PD Outcomes**

In the four EPPI centre reviews, outcomes were commonly described through their relationship to teacher impact. Inconsistencies were evident between the different review summaries in terms of the types of outcomes that were considered; for example in the first review (Cordingley et al., 2003,), impact on teachers was separated into two areas: *the development of teachers' knowledge and skills; the development of teachers' beliefs, behaviours or attitudes*. There was no clarification of teacher skills in terms of specific examples and how they differed from teacher behaviour. The third EPPI centre review (Cordingley et al., 2005b,), whose main focus was on the impact of CPD research, categorised outcomes differently to the first, using two broad clusters: *affective and behavioural data*. Whilst the reviews had different research foci and questions, the

inconsistent use of terms and outcomes highlighted the complexities surrounding this area of CPD research.

Guskey's (2000) model for how to evaluate PD has five hierarchical levels with participants' learning at level two<sup>40</sup>. He posits the need to collect data is in line with a growing trend to assemble evidence on the effectiveness of PD programmes rather than looking at the time teachers are involved in different projects. Whilst this position is not well substantiated, he thoroughly describes three broad categories that can be used to classify teachers' learning as part of PD programmes: *cognitive*, *psychomotor* and *affective*. Cognitive refers to changes in PCK and other knowledge bases; psychomotor to alterations in classroom skills and practices, and affective to developments in attitudes and beliefs. The usefulness of this delineation is that it helps to structure the possible changes that teachers are likely to experience as they develop an ownership of the methodology. These three outcomes are in parallel with Joyce and Showers (2002) who conclude that nearly all teachers can gain new skills as part of an innovation and that the success of a programme is due to the design elements which bring about optimal conditions for teachers to learn and develop. They identify four outcomes for teachers who participate in a PD programme: *knowledge or awareness of educational theories*; *positive changes in attitudes towards self*; *development of skill*; *transfer of training and "executive control"*. Guskey and Joyce and Showers also share the same description for 'skill', which they both relate to classroom practice and behaviour; this is clearly different to the EPPI centre reviews which separated skill and behaviour, but without

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<sup>40</sup> The hierarchical model has five levels (5 high) which are arranged from simplest to complex in the following order: participants' reactions, participants' learning, organisation support and change, participants' use of new knowledge and skills, student learning outcomes.

clarification. The fourth outcome, “executive control”, they posit leads to changes in students’ learning environment that can in turn lead to raised student achievement. They also use a five-stage development model -levels of transfer- to rate a teacher’s implementation of an innovation. Executive control is the highest level and the description relates to Adey and Shayer’s (1994) stance on the transfer of ownership of the methodology from the specialists to the teachers through PD inputs. It is implied that the fourth is in some way dependent on the other three outcomes, but no elaboration is given other than how this outcome would positively relate to student achievement. It also raises the important consideration of the level of complexity of each outcome in terms of a comparison with teachers’ existing repertoire; this is drawn upon in the second design part of this section in relation to the selection of teachers.

In summary, the three outcomes of knowledge, behaviour in classroom, and attitude and beliefs encompass the main teacher changes that are to be considered for this RBT as teachers develop an ownership of the CASE methodology and are therefore part of the research questions. The literature review highlights the importance of the need to explore CPD processes (Cordingley et al., 2005b) and to consider the change process in terms of how teachers learn and develop (Desforges, 1995). Teachers’ learning has been proposed and researched through a constructivist approach where participants are active rather than passive learners (Adey & Shayer, 1994, Borko & Putman, 1995, Maverech, 1995). Therefore in order to explore the CPD processes, primarily focusing on teachers’ active learning, the mediating factors of teacher experimentation, modelling and collaboration, as well as specialist coaching, are to be considered in relation to the three outcomes. In

addition, the literature review highlights the differing perspectives on the characteristics of the change process, especially with respect to uniformity. The RBT intends to question how the change process can be characterised as it is an important consideration in terms of how teacher learn and develop. How all the different constructs are defined and empirically measured is considered in the first design part of this section in terms of an analytical framework.

### **The Three Research Questions**

The following are the questions for the RBT; the order is not hierarchical, but in the logical order of the outcomes of the change process and then the actual processes:

- *How does a teacher change in terms of his/her classroom skills, attitudes/beliefs and knowledge/understanding of the theoretical underpinnings of CASE as he/she develops an ownership of the methodology and how can the nature of the change process be characterised? (Question 1)*
- *How important to the process of change are the mediating factors of experimentation, collaboration, lesson observation with feedback and modelling? (Question 2)*

The research questions are focusing on how best to comprehend the change process in relation to the outcomes. They are not trying to obtain standardised, quantitative data, but rather qualitative data that focuses on understanding the change process. The data needs

to be able to describe the change process in terms of how a teacher changes in relation to his/her classroom skills, attitudes/beliefs and knowledge/understanding of the theoretical underpinnings of CASE as well as giving an indication of how important different mediating factors are to the process of change. Therefore for teacher change, qualitative data is needed to help answer the two main research questions.

A final consideration is that, as part of the CASE intervention, students' cognitive development is measured using Science Reasoning Tests (SRTs). It is standard practice to pre-test students at the beginning of the project and post-test them at the end to determine whether the intervention has accelerated their cognitive development. As already mentioned in the literature review, the third EPPI review (Cordingley et al., 2005b) found that if studies focused on teacher only outcomes, they focused on CPD processes and/or outcomes, but not on the pedagogy underpinning the PD in terms of students' learning. Therefore as SRTs are an established tool to measure students' progress cognitively, the RBT is to collect student data as well as teacher data as a subsidiary consideration. This is partly because students' cognitive development is the primary reason for the CASE scheme; in addition, as part of developing an ownership of the methodology, teachers use individual student scores to inform them of the type of conflict each student should be experiencing with the different activities. Therefore whilst the research is primarily focusing on teachers' development, the data on students' progress shows the value that the RBT places on the CASE pedagogy and it also should give an indication of the overall effectiveness of the scheme at the school. The final research question relates to student outcomes with respect to the CASE project:



- *Did the students show significant cognitive gains, with the primary focus being the whole cohort's results?* (**Question 3**)

The SRTs produce quantitative data and analysis is based on comparisons with standardised norms (Shayer & Wylam, 2001). The issue of the RBT collecting both qualitative and quantitative data is considered in the next part in terms of the research paradigm.

## ***Part II: Research Paradigm***

Whilst a précis of the dichotomous debate surrounding the two prevailing paradigms in social scientific research -normative and interpretive (Johnson & Onwuegbuzie, 2004)- including ethical, historical and political dimensions, is too complex and tangential for this thesis, a simplified delineation is useful in considering important methodological considerations. Cohen et al (2007) state that ontology, epistemology and models of human nature have ‘*direct implications for the methodological concerns of researchers* (p8).’ Therefore, this part briefly summarises these three areas from purist<sup>41</sup> perspectives and then reflects on the context of the RBT in terms of collecting qualitative teacher data and quantitative student data in relation to these methodological considerations. Finally, a pragmatic paradigm (Keeves, 1988, Alexander, 2006) is considered based on the purpose of the RBT.

### **Normative versus Interpretive**

From a purist paradigm position, the normative paradigm relates ontologically to a realist perspective (Anderson, 1998); through a positivist approach and based on a determinist view of human nature, it uses methodologies that produce quantitative data to find relationships between identified variables (Benton & Craib, 2001). The nature and the form of knowledge are inherently about trying to explain the facts, or realities, that allow generalisations to be made about humans’ behaviour and/or social phenomena (Husén, 1988). In direct contrast, a purely interpretive approach is based on a relativist perspective; through an anti-positivist approach, where humans are in control of their

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<sup>41</sup> For the purpose of the RBT, a purist or traditionalist perspective is one which is based solely on the fundamental tenets of the respective paradigm, especially with respect to its origins, and completely rejects any aspect of the alternative paradigm.

actions, it uses methodologies that produce qualitative data to try to interpret rather than explain the interactions and dynamics of social phenomena (Guba & Lincoln, 1985). It is important to note that these two summaries are extremely simplified, especially as they are taken from a purist position; both paradigms are most certainly not unitary with the more recent interpretive paradigm being extremely broad and eclectic in nature (Miller, Nelson & Moore, 1998) as well as there being clear differences amongst the exponents of the positivist approach (Phillips, 1983).

There is a multitude of literature that documents the paradigm debates, which centres on ontological and epistemological differences, especially when a traditionalist position is taken (Husén, 1988, Keeves, 1988, Johnson & Onwuegbuzie, 2004, Alexander, 2006). The dichotomous debate has been waged since the growth of the interpretive paradigm in the 1960s (Husén, 1988). As the more recent paradigm in social scientific research, one of the interpretive approach's major criticisms of realism is that observations are not free from values and that not all aspects of human behaviour are observable such as intentions and inner emotions (Anderson, 1998). There has been a growing literature which argues for the need for a unified (Keeves, 1988) and/or complementary (Husén, 1988) approach where commonalities are recognised and research can be carried out using mixed-methods/methodologies (Creswell, 1994). This is considered in the final part of this paradigm discussion in relation to a pragmatic paradigm and how it could be used by the RBT.

### **Context of the RBT**

Before a decision on the research paradigm can be reached, including whether it is necessary to take a purist position, it is important to take into account methodological considerations that relate specifically to the CASE project. Firstly, the perspective of the CASE project's founders would fit within the realist viewpoint, where knowledge is derived from a positivist approach; for example, the evidence for the effect of CASE lessons on students' cognitive development was obtained from an experimental design (Adey & Shayer, 1990). Whilst teachers' PD is the primary focus of the RBT, student outcomes are also being collected and analysed in the form of students' cognitive development, following the established method and procedural tools of the original research of the CASE project. This will involve using the SRTs as a tool to determine the 'reality' of students' levels of cognition. This position needs to be reconciled with the 'reality' of the teacher constructs identified in the research questions, which relate to PD and ownership of the CASE methodology.

Also of relevance is the dichotomous debate raised in educational literature regarding theories of learning, which highlights two important areas for consideration – the unit of analysis (Cobb & Bowers, 1999) and nature of research questions (Greeno, 1997). Theories of learning are very important to the purpose of the RBT as teacher change has been highlighted in the background literature as a learning process (Fullan & Hargreaves, 1992, Bell & Gilbert, 1996, Clarke & Hollingsworth, 2002). CASE is built on the tenets of the cognitive perspective (Adey, 1997) and, therefore, if the RBT takes a social perspective, it could mean a shift in emphasis from the individual to the interactions of individuals on a situated and/or social level. Therefore, it is important that clarity is given

to how teacher and student outcomes are to be defined and measured to ensure that the unit of analysis is the individual.

Salomon (1991) posits a systemic approach when research looks at different factors which are interdependent. This is applicable to the RBT as the research questions relating to teacher change are implicitly asking about the interdependency of the different constructs involved as a teacher learns and develops; this therefore advocates the study of patterns rather than single factors. For example, the interdependency of the mediating factors of collaboration and modelling need to be considered in relation to how they affect teacher outcomes rather than how they operate as dynamic, social processes. Finally, Anderson et al (1997) argue that research questions relate more to the nature of the preferred discourse; the RBT takes an opposite stance (Keeves, 1988), which is expanded upon below, where the purpose of the research drives the research questions, and subsequent research paradigm, rather than any preference. This position is partly because the research questions have two purposes which relate to teacher as well as student outcomes; therefore a different paradigm may be needed to reconcile the ontological and epistemological differences between how to obtain evidence to address the questions relating to both teacher and student outcomes.

### **Pragmatic Paradigm**

In deciding upon the research paradigm, Keeves (1988) posits that a pragmatic position needs to be taken where: *‘the purposes and functions of the research lie in the outcomes to be achieved from the research rather than the foundations for the research (p28).’*

Tashakkori & Teddlie (2003) state that pragmatism is the most commonly used paradigm in mixed-methods where the research question is more important than any method. In relating this to the RBT, the background literature centres on how teachers change, echoing Desforges' call (1995) for an explanation of the process, rather than a description of the 'milestones'. As mentioned earlier, the normative paradigm would certainly match the CASE founders' approach and therefore if the preferred discourse is to be the driving force behind the research, as suggested by Anderson et al (1997), then the purpose of the research in relation to teachers would have to change, including the research questions.

The primary focus of the RBT is teachers' PD; the research questions are looking at how a teacher changes by focusing on specific outcomes and mediating factors, that have been deemed relevant, as he/she develops an ownership of the CASE methodology; in addition, whilst there is a myriad of constructs under investigation, the 'how' questions are implicitly recognising the openness and flexibility that is needed for interpretation (Huberman & Miles, 2002) rather than asking for an explicit explanation of the specific relationships that exist between specific constructs. Therefore it is the purpose of the RBT, along with the research questions, that is dictating the type of data that is required. In order to allow for an in-depth look at constructs and how they relate to the process of change, the data needs to be qualitative and therefore from a purist position, the research purpose is aligned with an interpretive paradigm. If an interpretive paradigm is decided upon, the research question relating to student outcomes would possibly need to be omitted from the RBT. This is because in the context of CA research, students' cognitive development has been established from a positivist perspective; changes in students'

cognitive levels have been measured through quantitative means (SRTs), which would not fit within an interpretive paradigm.

May (2001) recognises the complexities involved with the complete separation of paradigms, stating that researchers who are positivists would not necessarily deny the place of subjectivity in social research. As mentioned earlier, there has been a movement to recognise a more complementary and unified approach to research. Keeves (1988) suggests that there is a unified view if researchers accept that the real world is affected by individuals' views and values and therefore on an epistemological level both paradigms would be trying to build up a coherent knowledge base about educational processes; this can be seen as a compromise between a realist and relativist position which is a characteristic of the pragmatist approach. More recently, Johnson & Onwuegbuzie (2004) support Keeves's (1988) unified position, stating that agreement has been reached on some of the major areas for disagreement between the respective paradigms, particularly that the '*light of reason*' varies amongst individuals and that inquiry is never value-free. They also emphasise that both paradigms advocate the need for empirical evidence as well as safeguards to be employed to reduce biases so that the validity or trustworthiness of the data can be understood. In addition, they comprehensively explain the tenets of the pragmatist paradigm, citing tables of general characteristics and weaknesses. This paradigm is extremely pertinent to the RBT as it is based on the middle ground and rejects traditional dualism, a position also advocated by Husén (1988) and Alexander (2006). It builds on the common ground between reality and relativism mentioned earlier and '*endorses a strong path to determine what works (p18).*'

To conclude, the RBT takes a pragmatist position with respect to a research paradigm. This position allows the tenets that the CASE project is built upon to be upheld and included in the research by looking at students' cognitive development as well as the primary focus of teachers' PD. It also allows the purpose of the research to be the driving force, where empirical evidence in the form of both qualitative -teacher outcomes- and quantitative -student outcomes- data is to be collected. The quantitative data allows for the 'reality' of student cognition to be measured so that the effectiveness of the CASE scheme can be determined. With respect to teachers' PD, the qualitative data is to be collected and analysed with a view to shaping a 'reality' that could be useful to other educationalists and practitioners; at the same time data is to be considered with an awareness that individuals' views and values can affect all aspects of the research.

Finally, Creswell (1994) highlights the debate concerning mixed paradigms and methods, identifying three prevalent models<sup>42</sup> in literature. The *dominant-less dominant* design is most aligned to the RBT where the qualitative and quantitative data is to be handled separately and concurrently; teacher change is to be researched through qualitative data and student progress through quantitative data. The qualitative approach is most certainly the dominant one as teacher change is the primary focus of the RBT; student outcomes are being included to emphasise the importance of students' cognitive gains to both the tenets of CASE (Adey, 1993) and PD research (Guskey, 2000, Joyce & Showers, 2002).

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<sup>42</sup> The three models of combined designs that Cresswell found in literature were: two-phase design, dominant-less dominant design and mixed-methodology design.



### ***Part III Methodologies***

Part III aims to show the possible methodologies that could be used for the RBT in relation to the identified research questions and paradigm. The pragmatic paradigm recognises that both teacher and student change can be studied through qualitative and quantitative measures respectively, in part because the purpose of the research is taking precedence over any preferred discourse. The main research questions relate to trying to understand the process of teacher change through collecting in-depth evidence which is aligned with qualitative data; therefore the three main educational qualitative methodologies -*Action Research, Case Study and Ethnography*- (Cohen et al, 2007) are each considered as possible approaches for the RBT. This part is therefore separated into a brief overview of each methodology, a consideration of how each methodology could relate to the context of the RBT and ends with a rationale for the selection of the most appropriate methodology.

#### **Action Research**

Cohen et al (2007) state that action research involves the planning and implementing of some kind of intervention that can be reviewed and evaluated by the researchers at a local level. Whilst much has been written about its historical beginnings especially in relation to Lewin (McNiff, 2002, Boog, 2003), one of the founding exponents of the methodology, there are underlying differences regarding the types of action research, including the role of theory and differing roles of researchers (Kemmis & McTaggart, 2005). Koshy (2005) summarises different action research models which contain many of the same aspects of Lewin's earliest model through an iterative process of: *planning*,

*acting, observing and reflecting*, which guide researchers rather than giving a rigid structure. Zeelen et al (2008) acknowledge that whilst there may, at times, be competing orientations within the field of action research, there are core characteristics which centre on a shared democratic participation for human development through emancipation and empowerment where: *‘researcher and researched subjects become researcher and participant researcher in a mutual learning process (p3).’*

### **Case study**

Case studies are a well established methodology in social scientific research which allow for an in-depth study into complex constructs and relationships (Edwards & Talbot, 1999). They are non-interventionist in nature and very much focus on the uniqueness of a particular case (Nisbet, 1974, Simons, 1996, Cohen et al., 2007). *Case studies typically involve participant observation in terms of the researcher, but can use a range of methods, depending on the context and level of structure of the research (Cohen et al., 2007).* Case studies have been separated into various types, which relate to the complexity surrounding what exactly constitutes this methodological approach (Bassey, 1999, Cohen et al., 2007). Stake (1995) and Yin (1994) are two American researchers who have written extensively on case studies. Bassey (1999) notes a clear distinction between the two where Yin’s research and writings have a more positivist tendency, whereas Stake’s work lies firmly within the interpretive paradigm. Yin (2006) states that: *‘compared to other methods, the strength of the case study method is its ability to examine, in –depth, a ‘case’ within its ‘real-life’ context (p111).’*

## **Ethnography**

The early beginnings of ethnography are seen as coming from social anthropology (Silverman, 2005); May (2001) states that it was the Chicago School of Social Research that advocated the study of social phenomena through observation, in particular focusing on its evolving nature. Therefore, ethnography centres on naturalistic enquiry, using a range of procedures to gather data (Jessor, 1996). Whilst the ethnographic methodology has core underlying principles, it is seen as a heterogeneous movement (Walford, 2002), especially with respect to the role of theory (Fetterman, 1998, Wacquant, 2002, Tavory & Timmerman, 2009). Hammersley (2002) posits that ethnography is about trying to understand rather than judge behaviour where the role of the researcher is one of observation. He acknowledges, however, that all our perceptions and observations are laden with assumptions. In relation to its anthropological roots, May (2001) states that ethnography encourages researchers to immerse themselves in their fieldwork where they are the research tool to collect data.

## **Consideration of methodologies**

It is important to note that whilst the three methodologies have been described separately, there are overlaps between them (Hammersley, 1998, May, 2001); for example, both ethnography and action research have been categorised as types of case study<sup>43</sup> (Bassey, 1999). Therefore this sub-part draws upon the most established elements that help distinguish each methodology rather than the areas of common ground or issues of categorisation.

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<sup>43</sup> Bassey notes that ‘*Stenhouse describes four types of broad styles of case study- ethnographic, evaluative, educational and action research.*(p27)’

All three methodologies offer the advantage for the RBT of a naturalistic setting, which would involve studying the process of change as teachers develop an ownership of the CASE methodology. A recurring theme, in the literature of all three methodologies, is the role of theory within research; in addition, a common criticism of qualitative research concerns the lack of ability to generalise findings to the wider population as well as the trustworthiness of the findings (Cohen et al, 2007).

With regard to the role of theory, the main debates in case study and ethnography are very similar in terms of the inductive and/or deductive nature of the research (Wilson & Chaddha, 2009). With action research there is a similar dichotomy, but the emphasis is more on the type of theory and knowledge, such as external technical knowledge versus personal tacit knowledge (Whitehead, 1989, McNiff, 2002), rather than how theory affects the process of research (Kemmis & McTaggart, 2005). There is, however, a similar issue in all three about how theories are generated based on participants' perspectives. It is clear within the literature of each methodology that different types have been identified partly because of the evolving nature of research (Cohen et al, 2007).

Each type, irrespective of the methodology, can be distinguished from the others by looking at how theory affects research questions, methods and data analysis as well the types of conclusions that can be drawn (Zuber-Skerritt, 1996). The RBT would fit the category of using both an inductive and deductive approach to research (Wilson & Chaddha, 2009) which recognises that the role of theory can be seen as existing along a

continuum. In the context of the RBT, the deductive, theory-testing aspect relates to the conjecture that teachers' learning is through a constructivist perspective where development happens through 'active' processes; in contrast, the nature of the development process, including the role of mediating factors, is through an inductive process which relates to the 'how important are' type questions, which contain no reference to any kind of prediction. This role of theory is a key aspect of the whole research process and therefore is to be considered in greater detail in the next part of this section.

A key distinguishing feature between the methodologies is the differing roles of researchers and participants. All three methodologies would allow me to be the primary researcher, but would differ in how I would work with the participant teachers. With action research, the participants would have a greater involvement with the research as the purpose would be to empower them to reflect on their practice through some kind of intervention (Volk, 2009). In addition, the core ontological tenets of action research make it clear that the methodology is about a democratic empowerment of individuals (Boog, 2008) which is not the purpose of the RBT and therefore would be difficult to reconcile. With ethnography, the researcher's main role is to observe (Atkinson, 1992). It would therefore mean that I could not be both the CASE trainer and main researcher in terms of observation; this would in turn mean that I would need to recruit a researcher with some CA background and agree terms of reference. A case study would allow me, however, to be both the researcher and trainer without altering my role as the sole researcher with

respect to all aspects of the research. My multiple roles would, however, need to be considered especially in relation to the participant teachers.

To conclude, a case study is the most appropriate methodology because it is reconciled with the theoretical approach of the RBT, including research questions and paradigms, as well as allowing me to be both the main researcher and CASE trainer. In addition, as a researcher a range of data collection tools would be available to me beyond observation, which could be done concurrently with my other roles. Regarding the role of theory, the 'how' questions are aligned with an explanatory case study (Yin, 1994) where existing literature forms the theoretical basis to test theories (Bassey, 1999). The idea of testing theories, however, appears to advocate a purely deductive approach. There is an inductive nature to the RBT, which is reflected in the research questions; they have an openness to allow the evidence to be used to help understand the nature of the process of change. Therefore, this needs to be explored and made explicit in the design and methods parts of this section in terms of the procedural and analytical tools.

## ***Part IV: Selection of Methods***

In order to select the methods to use for the RBT, this part explores the different types of case study, including theoretical underpinnings; considers the issues of using mixed-methods and discusses the location of the research. It ends with the selection of methods to be used to gather empirical evidence to answer the research questions on teachers' PD.

### **Type of Case Study and Theoretical Underpinnings**

In terms of types of case study, Stake (1995) uses the distinction between *intrinsic and instrumental case study*<sup>44</sup>; the former focuses on the particular context, ignoring external concerns, whereas the latter looks at one or more contexts in order to understand external concerns. Yin (1994) proposes *exploratory, descriptive and explanatory* as a particular strategy which depends on the research question, the control of the researcher, and the actual focus in terms of current or past events. Whilst the distinction between the types is, at times, quite ambiguous, partly because other methodologies are considered at the same time, the former is aligned with 'what' questions and linked with initial work to help develop hypotheses for further research. Descriptive case studies are detailed narrative descriptions of a particular phenomenon which are generally not trying to build and/or develop theory. Finally, explanatory case studies relate to 'how' and 'why' questions which are trying to illuminate themes and patterns.

Bassey (1999) advocates a reconstruction of case study and suggests three categories: *theory-seeking and theory-testing case study; story-telling and picture-drawing case*

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<sup>44</sup> Stake (2000) added *collective* case study to the original two which is described as the product of several instrumental case studies that can be used to generalise and construct theories.

*study; and evaluative case study* (p62). The first category is chosen because it can in some way represent the general. Bassey (1995) suggests that this type is aligned with Yin's (1994) exploratory (theory-seeking) and explanatory (theory-testing). In addition, as the focus is the general issue rather than the actual case, he posits it is similar to Stake's instrumental case study which tries to understand external concerns. Bassey suggests that story-telling and picture-drawing are aligned with Stake's intrinsic and Yin's descriptive case study; this is because they are all analytical accounts of particular events which try to give theoretical insights, but are more discursive in nature compared to the theory-seeking and -testing types. The evaluative case study is seen as a distinct type whose primary aim is not the development of theory, but rather the evaluation of the worthiness of a particular case. Bassey's reconstruction, which looks for similarities among the leading exponents of case study research, recognises that in any categorisation process there are issues of overlap as well as omission and that it is about the usefulness of the new categories especially the: '*importance of educational theory in different forms* (p64).'

In terms of the relationship between theoretical considerations and the type of case study, Cresswell (1994) suggests that one of the difficulties of theory in qualitative research is the lack of standard rules regarding its placement within research. Yin's (1994) explanatory case study relates to the RBT in terms of the open-ended 'how' questions; in addition, the research questions are trying to illuminate themes and patterns between constructs rather than any causal- or correlation-type relationships. In addition, Stake's (1995) instrumental case study, which is aligned with the explanatory, is associated with the 'external' nature of the RBT where the overall aim is to understand processes and



outcomes that relate to teachers' PD with the CASE methodology which may be of general use to others.

Deductive and inductive reasoning have been discussed in the methodology part as an important consideration of the role of theory in qualitative research (May, 2001). As already mentioned, the RBT, through the qualitative teacher focus, is using a theoretical basis for the research, primarily advocating that teachers' PD is through a constructivist approach to learning; at the same time, however, it recognises that the nature of the questions are open and therefore inductive reasoning is also being used. In terms of theoretical underpinnings, the RBT intends to use existing literature to help structure an analytical framework in relation to the constructs identified in the research questions; this will be explained in the next part of this section.

To conclude, the RBT fits an explanatory case study because it is looking at 'external' theories that have been considered in the literature review rather than a 'one-off', unique situation.

### **Mixed Methods**

The case study methodology allows for a wide range of methods and/or sources of evidence to be considered (Yin, 1994, Bassey, 1999, Eisenhardt, 2002). Before consideration can be given to these areas, the use of mixed-methods is to be reflected upon.

Greene et al (1989) reviewed fifty-seven studies that deployed mixed-methods and identified five purposes for mixed-methods evaluations – *triangulation, complementarity, development, initiation and expansion*. The review highlights the common misuse of triangulation in research, which they argue should only be stated when mixed-methods are being used to study the same phenomenon; this position is reinforced by Cresswell (1994), Yin (1994) and Holden (2000). Of the five purposes, the RBT is most aligned with the expansion purpose which: *‘seeks to extend the breadth and range of inquiry by using different methods for different inquiry components (p259).’* Of the seven design characteristics<sup>45</sup> that are identified, phenomenon is extremely pertinent to the RBT as mixed-methods require clarity about how the research tools relate to the different phenomena being studied. For example, lesson observation is a focus of one of the research question; therefore, irrespective of how data is collected, to address this question, the phenomenon under investigation is teachers’ classroom practice and is related to teacher outcomes. When looking, however, at the impact of providing feedback of lesson observations, the phenomenon is different as it focuses on the use of coaching as a mediating factor and is therefore focused on the process of change.

In summary, the application of the expansion purpose to mixed-methods builds upon the recommendation of the EPPI centre (Cordingley et al., 2003) in terms of the need to identify and make explicit the different phenomena being studied.

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<sup>45</sup> The seven characteristics of mixed methods design based on the reviews of the fifty-seven studies are: methods, phenomena, paradigms, status, implementation-independence, implementation-timing and study.

### **Location of the Research**

One of the main reasons for the selection of a case study methodology is that it allows me to be a participant researcher. In terms of the location where the research is to be carried out, the limiting factor is my employment status which means it would only be feasible for me to work with one school. In addition, as I am a full-time Deputy Headteacher, I would probably need to change my employment status for the duration of the data collection part of the research, if I decided to work with teachers in a different school to my own. Also, as there are no neighbouring secondary schools in the LA who are currently delivering the CASE scheme, it would be difficult for me to find a school that would be willing to start the scheme and, at the same time, be part of the research. Therefore as my school has the scheme well established, and I would be in a good position to conduct the research without compromising my employment status, the case study is to be situated at my school.

### **Selection of Methods**

Johnson and Turner (2003) suggest that one of the fundamental principles of mixed-methods is a recognition of the strengths and weaknesses of each method. In addition, the processes involved in using multiple data sources include identification of convergence, elimination of other key plausible explanations as well as recognition of divergence. They note six different methods: *questionnaires, interviews, focus groups, tests, observation and secondary data* (p298). Questionnaires and tests are not appropriate methods as they are generally associated with larger- scaled research, where quantitative data is collected to gain evidence about causal or correlation-type relationships between

relevant constructs (Cohen et al., 2007); in addition, there is no secondary data that is of relevance to the RBT as a main data source. Therefore, the three main methods that could be used are observation, interviews and focus groups which are also aligned with the sources of evidence outlined by Yin (1994) and Bassey (1999).

Desimone (2009) emphasises in PD literature the difference between evidence obtained from naturalistic observation compared with self-reported data from interviews and surveys. Anderson (1998) suggests that interviews are a prime source of data for case studies whereas Silverman (2007), focusing primarily on ethnographic research, describes interview data as manufactured and thus advocates the use of naturalistic observation. May (2001) suggests that for a more holistic understanding, the researcher needs to have witnessed the context or set of circumstances that the interviewee is referring to. In order that the data collected is not seen as solely self-reported and manufactured compared with naturalistic observation, the RBT is to adopt two methods – interviews or focus groups and lesson observation.

Focus groups can be seen to fit broadly within the conversational or oral aspect of qualitative research where the emphasis is about the group dynamic as well as gathering information (Flick, 2006). Similar to interviews, the data collected is self-reported. It does allow for an in-depth exploration of collective ideas, but is subject to several biases, including the domination of certain individuals as well as demand characteristics (Johnson & Turner, 2003). As the RBT is focusing on an individual teacher's PD rather than a group's development, an interview between researcher and each participant teacher

is preferable to a focus group so that participants' opinions and ideas can be explored on an individual basis.

Silverman (2007) states that interviews and observations are commonly used together in mixed-methods. Desimone (2009) urges for a move away from the criticisms and biases which are attributed to observation, interviews and surveys, especially with respect to the comparability of collected data. Her position is partly based on more recent evidence which does show a greater degree of correlation compared with earlier studies in terms of observation with self-reported data. She suggests that social desirability affects all data collection; if, however, data is confidential in relation to teachers' behaviour and is not related to teacher evaluation (Mayer, 1999), interviews, surveys and observations can elicit comparable information.

To conclude, the two main methods of collecting data to try to answer the research questions that relate to teachers' PD are observation of CASE lessons and interviews with teachers. The main reason for using two mixed methods is that it will involve naturalistic enquiry through lesson observation to gather data on teachers' adoption of the CASE methodology which is central to the aim of the research. Interviews will be used to gather data on all the other constructs and, whilst this is self-reported data, my involvement as a trainer and coach should support the validity of the findings (Arksey & Knight, 1999). Careful consideration will need to be given to the comparability of the data from two different methods and identification of the phenomena being studied by each method. In

relation to student outcomes, SRT data for students is to be collected to measure students' cognitive development.

The next two design parts outline the decisions that were made when developing the research tools and therefore the tense changes accordingly.

## ***Part V: Design I- Analytical Framework and Research Tools***

As already discussed in Part IV, the approach used for the RBT was an explanatory case study, using an inductive and deductive rationale in relation to the role of theory. The main deductive approach was the formulation of an analytical framework based on existing literature to support the data collection and subsequent analysis of the lesson observations and interviews. The inductive element was through the openness of the questions, where the ‘how’ questions for teachers’ PD were not based on any predictions of expected teacher outcomes or the effects of different mediating factors.

This part is separated into an explanation of the analytical framework that was used to structure and develop the research tools; it ends with a description of each research tool.

### **Analytical Framework**

All the constructs that constituted the two main research questions on teachers’ PD were defined as part of the initial design stage. The constructs were separated into outcomes which related to Question 1 and processes which related to Question 2. I devised the qualifying descriptors, using my CA knowledge and experience, and pertinent PD literature.

Eisenhardt (2002), when considering theory-building from case study research, emphasises the importance of an early identification of research questions and constructs, but with the caveat that they are tentatively formulated and should be subject to revisions.

Therefore the constructs, through an iterative process, were refined, in part, through the nature of the evidence obtained; the original qualifying descriptors can be found in appendix 2. The only changes that were made were that descriptors were added for each mediating factor which had not been done in the first version. The final version is shown in Table 1.



- **Table 1** Analytical Framework for the constructs relating to teachers' PD contained in the two research questions

<b>Outcomes (Question 1)</b>	<b>Description</b>
<b>Knowledge and understanding of CASE methodology and pedagogy (K&amp;U)</b>	<i>Specific references to the CASE pedagogy in terms of theoretical underpinnings, including Piaget and Vygotsky, as well the methodology in relation to the use of the CASE pillars, reasoning patterns as well as the role of the teacher and students</i>
<b>Attitude and Beliefs (A&amp;B)</b>	<i>Any reference to an opinion and/or a positive or negative viewpoint such as confidence, motivation and difficulties</i>
<b>Classroom Practice (CP)</b>	<i>1 to 5 (5 high) grading system based on analytical models of Berliner (1988) and Joyce &amp; Showers (2002)</i>
<b>Sense of Ownership (SoO)</b>	<i>Teachers' adoption of the CASE methodology, through an internalisation/conceptual change that allows them to adapt and invent activities; judgements made using Mevarech's (1995) U-curve model: 1 to 5 grading system (5 high) from 1 – survival to 5 –invention</i>
<b>Processes (Question 2)</b>	<b>Description</b>
<b>Process of Change (PoC)</b>	<i>How teachers learned and developed, including cognitive processes that related to the constructivist theory of learning and development as well as how the change process could be characterised; it also included references to reflection</i>
<b>Mediating factors (MF):</b>	<p><i>Any factor used in the research that brought about changes in participant teachers' knowledge/understanding, classroom practice, and attitudes towards the CASE pedagogy and methodology, including:</i></p> <p><b>Lesson observation and coaching in relation to feedback (O)</b>- relating specifically to three formal observations, the observation schedule and the one-to-one feedback</p> <p><b>Experimentation (E)</b> – teaching and planning CASE lessons and using methodology in other lessons; there was some overlap between this factor and the three lesson observations, but the emphasis was on all their lessons and the preparation that this entailed.</p> <p><b>Modelling (M)</b> –demonstration by expert practitioner and watching videos</p> <p><b>Collaboration (C)</b> – any reference to INSET sessions, including watching videos</p>

In addition, in the initial design stage it was decided that the constructs of classroom practice and sense of ownership could benefit from additional structure, through the use

of PD models, mainly because of their importance to the overall research; the use of the PD models is explained in the next two sub-parts.

### **Classroom Practice**

Table 2 shows the two models –Berliner’s (1988) *development of expertise in pedagogy*, (1988), Joyce and Showers’s (2002) *levels of transfer*– that were used as a tool to interpret teachers’ adoption of the CASE methodology in the classroom. These models were discussed in the literature review and a précis is given in appendix 1b; they were selected because they both have five complementary stages to describe the progression of teachers’ classroom practice and involve the development of teachers from novice to expert. The literature review highlighted the relevance of novice-expert research to CASE in relation to teachers embarking on PD with an innovative classroom approach (Leat, 1999) especially in relation to the development of intuitive practice (Adey, 2004). Whilst this distinction has its critics (Cochran-Smith & Lytle, 1999), and would fit with criticisms of deductive reasoning in that it narrows and constrains the evidence (Eisenhardt, 2002), it was useful in helping to consider the nature of the change process. In addition, whilst Berliner’s is a generic model, Joyce and Showers’ was developed as part of empirical work to study teachers as they adopted a new classroom practice; therefore the combination of both was seen as strengthening the analytical tool, rather than narrowing it by the use of one or the other.

- **Table 2** Stage Development Models of Classroom Practice (Berliner, 1988, Joyce & Shower, 2002)

Level	Berliner (1988) The Development of Expertise in Pedagogy	Joyce & Showers (2002) Levels of Transfer
1	<b>Novice</b> <i>The commonplace must be discerned; the elements of the task to be performed need to be labelled and learned and one learns a set of context-free rules to guide behaviour. The behaviour of the novice is rational, relatively inflexible, and tends to conform to whatever rules and procedures they were told to follow. This is a stage for learning objective facts and features of situations. It is a stage for gaining experience.</i>	<b>Imitative Use</b> <i>Exact replication of lessons demonstrated in training settings.</i>
2	<b>Advanced Beginner</b> <i>Here experience can become melded with verbal knowledge, similarities across contexts are recognised, and episodic knowledge is built up. Strategic knowledge - when to ignore or break rules and when to follow them - is developed as context begins to guide behaviour. Experience is affecting behaviour, but the advanced beginner still has no sense of what is important.</i>	<b>Mechanical use</b> <i>Practice increases at this level, but there is little variation in type of implementation.</i>
3	<b>Competent</b> <i>Competent performers of a skill have two distinguishing characteristics. First, they make conscious choices about what they are going to do. They set priorities and decide on plans. They have rational goals and choose sensible means for reaching them. In addition, whilst enacting their skill, they can determine what is and what is not important. From their experience they know what to attend to what to ignore...teachers at this stage feel more responsibility for what happens. .competent performers are not yet fast, fluid or flexible in their behaviour.</i>	<b>Routine use</b> <i>Use of strategies is frequent at this stage; but alternative strategies are not considered at this point.</i>
4	<b>Proficient</b> <i>This is the stage at which intuition or know-how becomes prominent. Further, from the wealth of experience that the proficient individual has accumulated comes a holistic recognition of similarities. This holistic similarity recognition allows proficient individuals to predict events more precisely because they see more things as alike and therefore, as having experienced them before. The proficient performer, however, while intuitive in pattern recognition and in ways of knowing, is still analytic and deliberative in deciding what to do.</i>	<b>Integrated use</b> <i>Generally occurs for different models at different rates.</i>
5	<b>Expert</b> <i>They have an intuitive grasp of the situation and seem to sense in non-analytic, non-deliberative ways the appropriate response to make. They show fluid performance. They are not consciously choosing what to attend to and what to do. They are acting effortlessly and fluidly, behaving in ways that are not easily described as deductive or analytic.</i>	<b>Executive use</b> <i>Complete understanding of the theories underlying the various models and a comfortable level of appropriate use for varieties of models of teaching.</i>

## **Sense of Ownership**

Question 1 focuses on how teachers change as they develop an ownership of the CASE methodology. As this was seen as an abstract construct, it was decided that a stage development model was necessary to make this measurable so that judgements could be made based on the evidence. Throughout the literature review, the research of Mevarech (1995) had been highlighted as aligned with the RBT in terms of teachers' adoption of innovative practice through a constructivist approach to learning and development. A summary of the background to the U-curve model (Mevarech, 1995) is given in appendix 1b; it was chosen as the analytical framework for teachers' sense of ownership with the CASE methodology mainly because the descriptors are a combination of teachers' knowledge and understanding, attitude and beliefs, and classroom practice, which covered all the teacher outcomes in Question 1. In addition, the model describes the negative and positive aspects of the change process, which related to teachers' attitudes and beliefs; this had been discussed in the literature review as 'interference' which is suggested by Mevarech (1995) as essential to the process of development. The model was also seen as complementary to Berliner's and Joyce and Showers' PD models of classroom practice both in terms of description and five stages.

- **Table 3** Mevarech's (1995) U-curve model

<b>Stage</b>	<b>Description</b>
<b>Survival</b>	<p><i>The use of innovation is mechanical</i></p> <p><i>The focus is on physical changes in classroom and the logistics</i></p> <p><i>Experience teachers forget their rich pedagogical knowledge</i></p> <p><i>In planning lessons, the guidance is strictly followed and decisions are not based on pedagogical schema</i></p> <p><i>Assistance is focused on the technical side</i></p>
<b>Exploring &amp; Bridging</b>	<p><i>The approach to the new learning environment is more positive</i></p> <p><i>Teachers are preoccupied with themselves rather than with the students</i></p> <p><i>Teachers respond that innovation is going fine, but without reflective responses</i></p>
<b>Adaptation</b>	<p><i>Characterised by the reflective use of the innovation</i></p> <p><i>Discussion with colleagues is common about pedagogical problems</i></p> <p><i>Teachers are focused on students rather than themselves</i></p> <p><i>Planning is centred on the entire picture rather than short term outcomes</i></p> <p><i>Teachers use their knowledge about students' development and base their teaching on learning theories</i></p>
<b>Conceptual Change</b>	<p><i>Teachers use the innovation in a reflective and dynamic way</i></p> <p><i>Teachers can provide evidence of having experienced a conceptual change regarding the students and learning processes.</i></p> <p><i>Teachers are not concerned with technical issues, but rather long term effects</i></p>
<b>Invention</b>	<p><i>This is part of the conceptual change and is characterised by teachers using their conceptual change within the curriculum</i></p>

## **Development of the Research Tools – Interview, Lesson Observation and SRT tests**

These sub-parts explain the development of the research tools by exploring the different options and relevant background literature and include a justification of the reasons for the final design decisions.

### **Type of Interview**

In qualitative research, interviews are described by Kvale (1996) as a conversation between two unequal partners. Yin (1994) states interviews are one of the most important ways of collecting data in case studies. Much has been written about the types, structure and categories of interviews (Cohen et al, 2007). Rubin and Rubin (1995) relate different types of interview to the control that the researcher exerts over the conversation, which has led to the commonly used delineation of structured, semi-structured, and unstructured. Using these three categories, Arksey and Knight (1999) state that structured ones are usually used for collecting standard information from participants, whereas unfocused ones are generally used to help prepare for more structured interviews. Semi-structured interviews are noted to be the most common type of interview in qualitative research.

For the RBT, the semi-structured interview was seen as the most suitable because it allowed for an interchange between researcher and interviewee where the general structure was decided in advance, but where themes could be developed throughout the interview and additional questions could be asked to explore particular responses.

### **Types of questions**

In terms of types of questions, Rubin and Rubin (1995) suggest that there are three types of questions: *main, probes and follow-up* (p145). In relation to main questions, Cohen et al (2007) note several advantages to open-ended questions which include flexibility, probing, establishing a rapport and allowing for unexpected answers. Rubin and Rubin (1995) state that probing questions are an essential part of the conversation and can be used for clarification, for eliciting more detailed answers especially with ‘closed’ type questions, and to show the interviewer’s attention to the interviewee’s responses. Finally, the follow-up questions are very much a feature of semi-structured interviews where themes can be explored.

It was decided to use between eight to thirteen questions for each interview over the course of the year partly based on an estimation of an optimum time period. The main questions were decided in advance – their construction is expanded upon in the next sub-part. In addition, probing questions were used as they allowed for the correct level of detail and depth to be obtained from each interviewee to specific questions. Finally, follow-up questions were employed to explore tangential themes, which again related to the inductive approach to the data collection.

### **Construction of Questions**

The main questions were chosen based on the analytical framework as well as the two research questions on teachers’ PD. The interview questions for each semi-structured

interview can be found in appendix 4d and are labelled in terms of the research construct they were intended to gather data on.

In the first interview, the focus was primarily on teacher outcomes – knowledge and understanding and attitudes and beliefs - as it was important to be able to gather data on changes in these constructs over the course of the research year. In addition, changes to classroom practice were explored, but these questions were re-categorised to experimentation during the processing stage of the interview transcripts. The second interview took a more themed approach to the questions by looking at some of the constructs through the foci of the role of trainer, INSET sessions and teachers' PD. The questions for the last interview were focused on gathering data on all of the constructs, especially on how the teachers had changed in relation to outcomes and through which processes.

Overall, it was decided to use a balance between open and closed questions, directly focusing on one or more constructs, with the former type questions being related to the inductive part of the research with several questions in each interview beginning with 'how'. When closed questions were used, a follow up question was used to elicit more open responses. In addition, general questions were incorporated into each interview; this indirect approach, identified by Tuckman (1972) to elicit candid and open responses, again related to the inductive nature of the research where interviewees could emphasise their thoughts about their development without being directed to a particular construct.



In terms of the construction of each question, the advice of Arksey and Knight (1999) was used to avoid the use of imprecise and ambiguous vocabulary as well as the recommendation by Cohen et al (2007) to consider an interviewee's knowledge base and his/her access to the information in relation to memory recall. Therefore I made sure that any technical language, such as Piagetian and pedagogical, was understood by participant teachers through PD inputs such as INSET sessions and that the context of the questions related as much as possible to recent occurrences.

### **Type of Lesson Observation Schedule**

Desimone (2009), in her discussion on the comparability of data collected through different methods, suggests that, even though lesson observations are time-consuming, when conducted properly observations can: *'provide comprehensive, objective measures of what occurs in PD and resulting classroom instruction (p191).'* Hopkins (2002) suggests four categories for the observation method which are *open, focused, structured and systematic* and therefore both qualitative and quantitative data can be collected. Yin (1994) recommends the use of more than one researcher and observational protocols to support the reliability of the data collected. Bassey (1999) emphasises the role of the researchers in terms of their personal skills by putting the participant teachers at ease, and their cognitive skills through the identification of salient aspects of the lesson.

### **CA Approaches to Lesson Observations**

A variety of techniques has been used by the CASE team at King's College, London, and CA tutors to produce written evidence of CASE observations and then provide feedback

to teachers (Adey, 2004). The different approaches include a transcript of the dialogue between teachers and students with a commentary alongside (Shayer and Adey), compared with less detailed feedback on the content of the lesson, but more emphasis on strengths and areas for improvement, which is aligned with coaching (Hamaker & Harrison). In terms of Hopkins's (2002) observation categories, open observation would fit the approach used by Shayer and Adey where the dialogue and activities are noted. Focused observation can be used to concentrate on a particular technique or aspect of the lesson such as a teacher's questioning skills, where an aide-memoire may be useful. In structured observations, information is gathered through a tally system or diagram. Finally, a systematic observation uses coding scales because the aspects of interest are too frequent to be an open observation and too complex for a structured type.

### **Observation Schedule**

A CASE observation schedule was developed as an observation tool by N. Mbano (2001), a PhD student of Adey, as part of his research into the use of CASE in Malawi. Her decision to use a systematic observation schedule as opposed to ethnographic observation was partly because it fitted within the positivist paradigm. She noted several strengths of this type of observation, which included: *'to monitor the development of teachers (p148).'*

It was decided to use this observation schedule as it helped to structure the data that was collected in a systematic way in relation to the CASE pillars; it was decided that data being collected was compatible with the PD models (Berliner, 1988, Joyce & Showers,

2002) being used to interpret and judge teachers' classroom practice. For example, if a teacher spent too much time on the concrete preparation pillar, this would be an indication of a novice practitioner in terms of his/her focus on the technical aspects of the lesson as opposed to the more challenging cognitive activities.

Mbano recognised some of the criticism of this schedule where the pre-specification of how data should be seen and collected is a type of observer bias (Anderson, 2002), which can lead to a partial, rather than a full, picture. In order to address these criticisms and to incorporate explicit feedback for use as a tool for coaching<sup>46</sup>, the observation schedule used by the RBT incorporated the approach of Hamaker & Harrison (Adey, 2004) of using a qualitative commentary, focusing on strengths and recommendations. Therefore the additional qualitative data had a dual purpose – evidence of the level of teachers' classroom practice with the CASE methodology and commentary to be provided as feedback in coaching sessions. As a research tool, the qualitative statements on strengths were used to give an indication of each teacher's competency, whilst the recommendations were mainly used in coaching sessions for identifying areas for development for the future.

It was decided not to use the analytical framework of PD models (Table 2) during the lesson observation so that it did not influence the nature of the statements. In addition, it was not shared with the teachers in terms of an overall judgement. The RBT took the position that the self-reported data was more likely to be affected if the participant

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<sup>46</sup> Coaching, as a mediating factor for change, is outlined in the Part IX on PD inputs.

teachers felt a summative evaluation was being made on their classroom practice; this was based on the previously mentioned literature on the comparability of interview and observation data in relation to social desirability (Desimone, 2009) and teacher evaluation (Mayer, 1999).

In terms of conducting the observation, I was the sole observer. It would most certainly have been beneficial to have a second observer for several reasons including the validity of the evidence (Yin, 1994), especially the difficulties I faced in having to collect both qualitative and quantitative data. It was not possible, however, to recruit a second observer mainly due to time and financial constraints.

### **Science Reasoning Tests (SRTs)**

Whilst research Question 3 is a subsidiary consideration, it does reflect the importance this study places on the overall purpose of CASE to accelerate students' cognitive development. This method allowed the RBT to consider the effectiveness of the CASE scheme at the school.

The standard method is to test the students using the established research tool of the SRTs. These have been devised by the founders of CASE to measure students' cognitive levels. The standard pre-test is SRT II - *Volume and Heaviness*; this was formulated in the 1970s by Shayer and Wylam (1978). It was one of seven SRTs developed by Shayer and Wylam which built upon the interview approach of Piaget's Genevian School to determine participants' cognitive levels by developing tests that can be used with a group

rather than an individual. In order to measure students' cognitive levels at the end of the two year CASE intervention, the standard SRT used is either III or IV – *The Pendulum or Equilibrium in Balance*. All Piaget's protocols and the SRTs are criterion-referenced and there is no normalisation of participants' results. To allow sample data to be generalised to the population using the SRTs, the tests were standardised using an established psychometric test<sup>47</sup>. In the CSMS (Concepts in Secondary Mathematics and Science guide), Shayer and Wylam (2001) summarise the comprehensive reliability and different validity checks that were carried out in the establishment of the different SRTs.

During the conduct of the tests, it is recommended that students are encouraged to ask questions throughout (Shayer & Wylam, 2001) especially if they do not understand what the question is asking of them. To reduce administration bias, I conducted the test with each class as I was the most experienced practitioner in the department. An alternative would have been for me and/or the other Science teachers to deliver the SRT test on a one-to-one basis with students, following a Piagetian approach. This would have allowed for each student to ask for individual clarification with respect to the meaning of specific questions. This was not, however, feasible due to the time constraints involved in testing one hundred and fifty students individually especially as the test takes approximately forty-five minutes; in addition, it could have resulted in the data being less reliable due to administration bias.

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<sup>47</sup> The test used was the Calvert Non-Verbal Reasoning test because it correlated well with SRTs I, II and III and it tested a similar age range.

## ***Part VI: Design II - Time Period and Teacher Selection***

This second design part is separated into a discussion of an appropriate time period for the research, a timeline of the research, the process for selecting participant teachers, and finally with a 'pen portrait' of each teacher.

### **Time period**

In terms of PD programmes being seen as sustained, the EPPI centre reviews selected studies that were a minimum of three months and had to include follow-up activities. Desimone (2009), when outlining critical features of PD, states that duration is important for the process of change. She notes that: *'research has not indicated an exact 'tipping point' for duration but shows support for activities that are spread over a semester and include twenty hours or more of contact time (p 184).'* The CASE project is traditionally taught over a two year period (Adey, 1993). One academic year -September, 2007 to July, 2008- was selected as the time period for the RBT because teacher-turnover and timetabling constraints did not allow it to be a two-year piece of research. In addition, one year was chosen for pragmatic reasons to see if this time period worked in terms of developing effective CASE practitioners. Finally, one year was seen as a long enough period of time based on other sustained PD research (Desimone, 2009) to collect data on how teachers change. In terms of student outcomes, however, it was decided to collect post-SRT data at the end of the second year, as well as the research year, because the students would then have completed the full CASE programme.

The timeline for the research is shown in Table 4; this shows the time period for the preparation of the research, the use of the different research tools and PD inputs from the summer term of 2007 to the autumn term of 2009.

- **Table 4** A timeline of the research in terms of data collection and PD Inputs

	Summer Term 2007	Autumn Term 2007	Spring Term 2008	Summer Term 2008	Autumn Term 2008	Autumn Term 2009
Ethical approval for research						
Approval from Headteacher						
Selection of teachers, including agreement to participate						
Meeting with participant teachers to discuss the specific detail of the research, including procedures for data collection and PD inputs						
Meeting with the whole of the Science department to explain the aims of the research and to invite them to attend the half-termly INSET sessions						
Questionnaire completed by each participant teacher						
Pre-test (SRT II) carried out with all Year 7 students						
One lesson observation of each participant teacher, followed with individual feedback						
One lesson demonstration for each participant teacher to observe with their CASE class						
Two INSET sessions for all members of the Science department						
One interview with each participant teacher						
Feedback forms on CASE INSET sessions completed by members of the Science department						
Post-test (SRT II) carried out with all participant students (half way through CASE programme)						
Post-test (SRT IV) carried out with all participant students (completed CASE programme)						



The initial intention had been to do a demonstration lesson once every term, following the same pattern as the lesson observation. Due to time constraints, however, and a concern about the optimum placement of modelling techniques, which will be highlighted in the results section, a demonstration lesson happened only once for each teacher in the autumn term. A calendar displaying all the key dates can be found in appendix 10. The specifics of the different data collection procedures are outlined in Part VIII and the PD inputs are expanded upon in Part IX.

### **Teacher Selection**

In terms of the selection of teachers, the sampling of teachers was constrained by the school timetable. Cordingley et al (2003) state that research papers often give very little detail about participant teachers and how they are recruited. Of the key factors involved in sampling, access to the sample was therefore the overriding reason for the selection of participant teachers. As the sample was not in any way trying to represent a population where results could be generalised upon, it was a non-probability sample (May, 2001). Creswell (1994) notes that in qualitative research, participants should be purposefully selected in relation to who will best help to answer the research question. This relates to purposive sampling (Cohen et al., 2007) where participants are selected because they are judged to possess a particular characteristic. Silverman (2005) states that purposive and theoretical sampling are synonymous with one another where the research setting and focus lead to choices, which are theoretically guided. As already mentioned, teachers' existing repertoire is an important consideration to the process of change (Joyce & Showers, 2002); therefore participant teachers who had a difference in their CASE

backgrounds were seen as useful when applying the framework of Maverech's (1995) U-curve model to how teachers develop a sense of ownership with the CASE methodology. In terms of the number of teachers, Cohen et al (2007) note that in qualitative research the sample size is generally small with cost being one of the limiting factors. Silverman (2005) concurs, stating that resources do not allow all cases to be studied.

It was decided to have three participant teachers, designated A, B and C, because my full-time employment status restricted the number of teachers I could work with in terms of conducting lesson observations, demonstration lessons and interviews; in addition, three teachers were seen as the minimum number that still allowed for a range of backgrounds with CASE to be studied. Of the ten Science teachers (not including me) there were only seven teachers who taught Year 7. Two of the teachers were automatically discounted as they were supply teachers, leaving five members of the department to choose from. As teachers A, B, C gave the most evenly distributed spread in terms of previous experience with CASE, they were selected as opposed to one or both of the other possible teachers.

### **Teachers**

Once the ethical board had given approval, the three selected teachers in the Science department were approached and asked to participate in the project. I explained to them individually the aim of the research and what their involvement would entail. I asked them to consider my proposal and to let me know if they wanted to be involved. All three teachers agreed to participate and signed a King's College participant consent form. The other members of the department were informed at the beginning of the academic year

about the research, including an invitation to attend the afterschool half-termly PD INSET sessions. A ‘pen portrait’ of each teacher is given below, which summarises his/her teaching background and experience with CASE.

### **Teacher A**

She qualified as a teacher in her home country of Australia. She had taught for two years in Australia before she came to live and work in the UK. She had been teaching in the UK for two and a half years primarily as a supply teacher. She taught at the school for a few months in 2005 as a supply teacher. She was appointed as a full-time member of staff in January 2007 after teaching in several other schools in the interim. She was introduced to CASE by me in the Spring Term 2007 as she was the designated CASE teacher for a Year 7 class. After a demonstration lesson by me and discussion on the pedagogy, she taught the next ten activities to the class. She had had no formal INSET with CASE and was, therefore, the least experienced teacher of the three involved in this research.

### **Teacher B**

He had been teaching for six years. He was first introduced to CASE at King’s College, London, during his PGCE course. He joined the school in September 2004 as second in the Science department. He did not teach CASE at the school he taught at after qualifying as a teacher, but had been regularly teaching CASE since he joined the school. Overall he had had very little formal PD with the CASE project, attending between three to four short INSET sessions.

**Teacher C**

She had been teaching for six years. She was first introduced to CASE at King's College, London, during her PGCE course. She was an NQT when her school joined the CASE network that I ran from 2001-2002. She joined the school in September 2006 as Head of KS 4 in Science. She had taught CASE regularly for the past six years. She had attended the CASE Convention twice. She was completing a MA (Master of Arts) in Education at King's College, London. Of the three teachers she was the most experienced in CASE in terms of INSET and teaching experience; she had never, however, been formally observed delivering a CASE lesson.

## ***Part VII: Ethical Considerations***

This part addresses ethical considerations in terms of the context in which the research was carried out, the participant teachers, the process of data collection *and the researcher's role*. Whilst the revised BERA (British Educational Research Association) guidelines (2004) were used as a universal structure for all educational research, it was also important to consider the context of my work as advocated in situated ethics (Simons & Usher, 2000).

Within qualitative research the issues concerning methodological and ethical issues are difficult to separate (Cohen et al., 2007). Anderson (1998) and Silverman (2005) both emphasise that the researcher is responsible for the research being conducted ethically and that the very nature of research, especially qualitative, is that not all eventualities can be planned for. May (2001) states that the amount of control that the researcher can exercise over the research will affect ethical decisions. This was certainly applicable for the RBT where, as the sole researcher working in my own school environment, I was able to make and act on decisions without much difficulty.

### **The Context**

The ethical issues that related to my role as Deputy Headteacher were considered and expanded upon in my request to the King's College, London, Ethical Board. The first issue was associated with my dual role in the institution once I embarked on the study. I was the Deputy Headteacher in charge of the upper school building, but was carrying out the research at the lower school site (a quarter of a mile apart). The groups of people I

primarily worked with were the students in Year 7 and members of the Science department teaching CASE lessons, with a particular focus on the three participant teachers. Due to my dual role, there were demands in terms of how I worked with the individuals involved, including clarity about roles and responsibility as well as a recognition of my seniority. Consideration of my role as a researcher is explored at the end of this part. Before I introduced the research to those involved, I sought permission from the Headteacher through a presentation to the members of the SLT involved in teaching and learning as well as the Head of Science. Again my dual role made it difficult to manage as I was part of the SLT and, therefore, I asked them to make a decision without my being present. Finally, I sought permission from the other CASE teachers as they might have been concerned that the data collected could have been used in some way to make comparisons about the effectiveness of Science teachers based on the students' SRT data.

### **Participant Teachers**

The BERA guidelines that were deemed relevant to the RBT in terms of responsibility to participants were *voluntary informed consent, right to withdraw and privacy*. For the RBT, once the selection process had been carried out, I met individually with the three participant teachers to outline the research, the level of commitment expected from them, their right to withdraw without explanation and the risks involved with comparative data. All three teachers agreed to participate. I gave them the King's College, London, consent form, which they all signed and returned to me. In terms of privacy, it states that it is the norm in research that participant data is treated confidentially and anonymously. Shulman (1990) states that there is a growing trend for teachers to want recognition of their

contribution to research, which can cause a conflict between anonymity and visibility. The 'pen portraits' of the teachers were extremely relevant when processing the data as their respective backgrounds needed to be taken into account. As the research was carried out in my school involving only three teachers, the ability for the teachers' anonymity to be upheld within the school community once the findings were published would not have been possible. This was explained to the teachers before they gave permission. The involvement of teachers in the validation process of my interpretation of their responses from the interviews helped address the issue of their lack of anonymity within the immediate school community. In terms of the students' SRT data, the classes that were taught by participant teachers were compared with the other classes; the groups were not matched, however, with their respective participant teachers because it was not the purpose of the research to compare individual teachers in relation to students' cognitive gains.

### **Collection of Data**

#### **Student Data**

When the tests were processed, the anonymity of the students was not initially possible as I needed to match the September test score with both the post-tests at the beginning of Year 8 and 9 respectively. Once the matching had been done, I was then able to give students codes A1- A25 for one class, B1- B26 for another class etc. This was necessary due to data protection. The actual tests were stored in one of the locked filing cabinets in my office. In terms of using the SRTs, there was no need to seek permission as I was the teacher responsible for organising the tests on an annual basis, including sending the results to the Science Reasoning team for analysis.

### **Teacher Data**

The lesson observation schedules were typed up and emailed to the respective teacher once feedback was provided during the one-to-one coaching sessions. For the interviews, the digital voice recorder was kept in a locked cabinet and the files were only copied once onto a CD (Compact Disk) when they were sent to be transcribed. I did not discuss or share the details and/or contents of the lesson observations and/or semi-structured interviews with any other member of the community. The participant teachers did, however, refer to the lesson observations during the INSET sessions, which generally started with individual reflections.

### **Researcher's Role**

The RBT involved me being the sole researcher, the CASE trainer, in terms of the INSET sessions, and a coach when providing one-to-one feedback on lesson observations. Lincoln and Guba (2002), through a discussion on the influence of values in case study research, note that a researcher's values are inextricably linked to all aspects of the research and therefore must be considered when drawing conclusions from research findings. This position is echoed by May (2001) and Silverman (2005). This is in accordance with the paradigm part of this section, where the pragmatic approach recognises that social scientific research is not value-free; therefore as the sole researcher and CASE trainer, my educational values were clearly going to have an influence on the research. For example, the longevity of the CASE project at my school has been because of my belief in, and commitment to, the underlying pedagogy and the need for ongoing



PD to support teachers in developing an ownership of the methodology. Therefore the participant teachers would have been fully aware from the beginning of my values with regard to the tenets of the CASE project.

Anderson (1998) posits that a researcher's personal interests can cause a conflict of interest with respect to his/her ability to make fair judgements, which Sadler (2002) refers to as value inertias. This meant that throughout the research I had to be aware of how my values and personal interests impinged on others. On the one hand, they have been integral to my role as a CASE trainer; in the context of the research, however, in order to minimise the bias of my known values and beliefs, when conducting the semi-structured interviews, I had to be able to manage the conversation so that the participant teachers felt comfortable and open to respond honestly about all aspects of the CASE project and PD programme.

One of the positive aspects for the Science department of my being the researcher, especially the participant teachers, was that they participated in teacher-led research; this has been advocated in the domain of education as a movement in the right direction for the teaching profession (Stenhouse, 1975, Burgess, 1985, Richardson, 1994, Fischer, 2001, Hopkins, 2002). Arksey and Knight (1999) outline several advantages and disadvantages to 'insider' research in the context of conducting interviews. One advantage that resonated with the RBT was that my knowledge and shared experience with my colleagues helped with the rapport during interviews; they suggest that: *'interviewees are more likely to be candid and open because they feel confident that the*

*interviewer believes them* (p67).’ In addition, they state that researchers’ familiarity with the participants can help with their judgement of the veracity of the account. Of the noted disadvantages, role conflict was the most pertinent especially considering my role as Deputy Headteacher as well as how any disclosures could affect future working relations.

To conclude, I carefully considered all stages of the research process and how I worked with all the different groups of people who were involved. I needed to ensure that I considered my dual role and the ‘power’ differences within established relationships. I used the BERA guidelines (2004) to structure the ethical consideration, but at the same time I was flexible and reflective in terms of contextual issues.

## ***Part VIII: Methods –Procedures for Data Collection and Analysis***

The part considers the specific procedures for data collection and analysis. It is separated into an overview of the data sources in relation to the research questions, a description of the procedures that were used to collect data, including any changes to the original plan, and an explanation of the approach to data analysis.

### **Data Sources and Research Questions**

Table 5 shows the different research constructs being explored in the RBT in terms of the three research questions and the three methods that were used to collect data.

- **Table 5** A summary of each construct in relation to its respective data source

<b>Research Question</b>	<b>Construct (MF – mediating factor)</b>	<b>Data Source /Method</b>	<b>Number of collection points</b>
1	Teachers' knowledge and understanding	Interview transcripts	Three
1	Teachers' attitudes and beliefs	Interview transcripts	Three
1	Teachers' classroom practice	Lesson observation schedules	Three
1	Teachers' sense of ownership	Lesson observation schedules and interview transcripts	
2	MF lesson observation and feedback	Interview transcripts	Three
2	MF lesson observation and feedback	Interview transcripts	Three
2	MF modelling	Interview transcripts	Three
2	MF collaboration	Interview transcripts	Three
2	MF experimentation	Interview transcripts	Three
2	Process of change	Lesson observation schedules and interview transcripts	Six
3	Students' cognitive levels	SRT test scores	Three

The use of mixed methods to study different phenomena (Greene et al., 1989) has been discussed in Part IV which states that it is essential that studies need to be explicit about the connections between different research tools and/or PD inputs.

Table 5 shows that for the majority of constructs, data was gathered through one method except for sense of ownership and process of change. All the constructs are considered below:

- **Question 1 – Teacher outcomes**

The qualitative data on the outcome constructs of teachers' knowledge and understanding, and attitudes and beliefs was collected through the semi-structured interviews with an awareness that all the different PD experiences would have directly and indirectly affected any changes (the focus of Question 2). The teachers' adoption of the CASE methodology in the classroom was measured solely by observation. The commentary of the lesson, however, had a dual purpose; it was used as evidence to support the judgement on teachers' classroom practice and as feedback to provide to teachers in a coaching session with the latter being considered at interview in terms of a mediating factor for change. This is an important example of the need to clarify phenomena when there is a connection between research tools and PD inputs (Greene et al, 1989) and relates to Salomon's (1991) systemic approach which recognises the interdependency of factors.

- **Question 1 – Sense of Ownership**

As previously mentioned, due to the abstract nature of the sense of ownership construct, it was decided that a PD model would benefit its interpretation and analysis, and complement the use of PD models with lesson observations. This construct therefore was a summative indicator of the combination of the changes in teachers' knowledge and understanding, attitudes and beliefs, and classroom practice; it therefore used both research tools indirectly as it was not based on the primary data, but on the interpretation of changes in the outcome constructs.

- **Question 2 –Mediating Factors**

The data on the effect of each mediating factor on the process of change was collected through the semi-structured interviews. All the different mediating factors related directly to the different PD inputs, which are outlined in Part IX, and are summarised below:

Collaboration	INSET sessions
Coaching	One-to-one feedback post lesson observation
Modelling	Demonstration lesson and video clips
Experimentation	Planning and teaching of CASE lessons and use of methodology in other lessons

The interviews were used to explore the influence of each mediating factor on the process of change with a clear understanding that any comparisons needed to be tentative as the methodology was not about any type of causality; the case study approach was to gather

qualitative data to gain an in-depth understanding of how teachers change as they adopt innovative classroom practice.

- **Question 3 – Process of Change**

This was the other construct that used both data from observation and interview to consider the learning process; the analytical framework was used to structure the analysis which was based on the deductive approach of focusing on constructivism and active processes to bring about changes. The majority of the evidence was based on teachers' self-reported data, but the lesson observation was useful as an indicator of progression and to verify teachers' accounts. In addition, this construct was equivalent to the sense of ownership construct in Question 1 as a summative explanation of the change process in relation to the different mediating factors and outcomes.

In summary, one of the main reasons for using an analytical framework was to be clear about each phenomenon/construct being investigated as well as the connections with different PD inputs.

## **Lesson Observation**

### **Procedure**

The plan was for me to observe each participant teacher once a term so that they had all been observed and given feedback three times over the course of the year. As the teachers taught thirteen CASE activities over the course of the year, this equated to them being observed for over twenty percent of the time. My full-time employment status, including my own teaching commitments, did not allow for any more observations. There

were no alterations made to the original plan other than it was not always possible to observe the three teachers delivering the same CASE activity. This was not seen as problematic as it was an individual teacher's progression that was the primary focus of the RBT. I observed each lesson generally using my laptop at the back of the classroom and then I agreed to meet each teacher a day or two later to provide them with feedback as well as give them a copy of the observation schedule. A few minor revisions were made to the observation template in consultation with Adey (September, 2007) in terms of the qualifying statements for each pillar. For each observation, the commentary was based on the findings of the observation schedule with specific reference to the CASE methodology. The completed observation schedules for each teacher can be found in appendix 3a, 3b and 3c respectively.

### **Analysis of Lesson Observations**

McCutcheon (1981) focuses on the importance of interpretation in lesson observation which is seen as a: *'transaction between the researcher's knowledge and the observations being made, and therefore as placing a researcher in an active role in the construction of meaning* (p10).' As a CA tutor, I was able to draw upon the knowledge I had developed to interpret the different lesson observations based upon my understanding of the CASE pedagogy and methodology. Interestingly, Landau (2004), when conducting lesson observations as part of CA research into secondary CASE and CAME teachers, had not experienced any CA PD or been part of the CA tutors' group.

Each teacher's lesson observations were analysed by looking for any changes in the cognitive activities, bearing in mind that different CASE activities were being observed each time, and the comments that were made with specific reference to the CASE methodology. An overall judgement level was given for each lesson, using the description that best matched the commentary. The juxtaposition of both models was used in a complementary way to aid analysis and therefore the terminology used in the analysis connects the CASE methodology to the models. The data analysis was qualitative as it described each teacher's development and used the strengths and recommendation as supporting evidence for the commentary using appropriate codes<sup>48</sup>. The systematic observation schedule could have been used to produce some additional quantitative data in terms of time spent on different cognitive activities. This was not done partly because the time periods were unreliable as they were crudely determined by me as the sole observer; in addition, as the observations were of different activities, the analysis was not about making quantitative comparisons in terms of time spent on different cognitive activities. There was, however, a qualitative use of the time spent on the different activities especially in relation to the lack of specific pillars, most notably metacognition, as well as the noting of qualitative changes in concrete preparation such as reducing the data collection part of the lesson to allow for more time for whole class discussion.

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<sup>48</sup>E.g. Code – LO1(S):a

LO stands for Lesson Observation, S for Strengths and R for recommendation; the number refers to the first, second or third observation -1, 2 or 3 - and the letter **a** refers to the ordering of the comments.



## **Semi-structured Interviews**

### **Procedure**

Once the questions had been formulated, the observation schedule was checked by my supervisors and revisions were made based on the feedback provided. The plan was to interview each teacher using a semi-structured approach three times over the course of the year, towards the end of each term, in order to reflect upon each teacher's respective progress and collect data on all questions relating to teacher outcome and processes. In addition, it was intended that the interview would always be after the termly lesson observation and half-termly INSET session. The interviews were planned to be held in a room at the lower school building. Finally, it was decided to record all the interviews using a digital voice recorder.

There were no major changes to the original procedures, but there were a few minor deviations. The reason to hold the interviews at lower school was because I was not based in this building and my upper school office was seen as more likely to cause associations for the participant teachers with my role as Deputy Headteacher. The first set of interviews in December all took place at the lower school building, but the remaining interviews all took place in my office. This was because of the logistics of trying to meet with the respective teachers when we were both free, including finding a room that was available. In addition, one interview had to be spread over two days because of time constraints. Finally, the intention was to begin each interview with reminding the participant teachers that this was solely about the research and did not in any way relate to my Deputy Headteacher position. This did happen for all interviews for the first and second round, but was not made explicit with any teacher for their final interview.

## **Transcription**

Kvale (1996) and Arksey and Knight (1999) both posit that it is an interpretation process where only the spoken words are transcribed into the written form, excluding all the other aspects of communication, such as emotions, tone, etc. The interviews were all transcribed using a professional service; one set of each teacher's transcript can be found in appendices 4a, 4b, 4c respectively. The transcriptions were checked by me especially to resolve any inaudible parts which often related to specific terminology, especially acronyms such as ZPD. It was decided that the purpose of the RBT did not necessitate that the transcriptions contained additional sounds.

## **Analysis**

Kvale (1996) notes that when analysing interviews what is not said can be as or more important than what is said. He suggests five different approaches to analysis of interviews: *condensation, categorisation, narrative, interpretation and ad hoc* (p191). Rubin and Rubin (1995) and Arksey and Knight (1999) also advocate the process of coding and categories, which relates to research questions and may be tentative to begin with and are revised as the research progresses.

Kvale's (1996) condensation approach to analysis was used where coding was based on the research questions and the constructs in the analytical framework. This was because it allowed for longer sentences to be reduced to shorter statements where an interpretation of meaning was based on the constructs and processes. In terms of the alternatives,

categorisation involves a reduction through producing tables and figures whereas narratives relates to stories; meaning interpretation leads to a text expansion and ad hoc methods relate to eclectic approaches. As a novice researcher, the condensation approach allowed for one method of data reduction to be used, producing qualitative data, which related to the original intention to understand the process of change. The issues of validity /authenticity of the analysis of the interviews are to be considered in the last part of this section.

The transcribed interviews were coded using the analytical framework described in Part V in terms of the constructs that related to the two research questions. As mentioned earlier, some revisions of the constructs, which were expected (Eisenhardt, 2002), were made at this stage to incorporate aspects of the participant teachers' responses - most notably in relation to the different mediating factors. Each construct was then analysed with respect to each teacher's responses to identify two or three themes and then compared with the other teachers; this helped with the categorisation of the themes, which were generally the same for each construct (appendix 4e). The commentary is evidenced by codes<sup>49</sup> that refer to my interpretation of a comment in relation to a particular construct and occasionally a direct quotation is taken to support a particular point. At the end of each commentary, the themes are discussed and used to answer the two questions.

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<sup>49</sup> The codes have one letter that refers to the construct e.g. M for modelling, K&U for knowledge and understanding while the numbering refers to the chronological order in which they were said in. E.g. M: 2 refers to the second comment made that referring to modelling.

The issues of validity and reliability of the research tools, including data analysis, is addressed in Part X.

### **Science Reasoning Tests**

The plan was for all the Year 7 students to take the standard SRT II pre-test, *Volume and Heaviness*, in September 2007. At the end of the academic year, 2007-2008, which was the time frame for the research year, the students were to take their first post-test. This was only one year into the CASE project and the students had completed only half the activities. As the cognitive levels expected in the SRTs -III and IV respectively- were too demanding for the early to mid concrete operational thinkers, the plan was to use again SRT II<sup>50</sup> - *Volume and Heaviness*. When the cohort had completed the CASE scheme at the end of Year 8, in July, 2009, the intention was that all students were to be post-tested for the second time using the recommended SRT IV – *Equilibrium in Balance*. The plan was that I would conduct all the tests to reduce issues of test administration.

The only main alteration was that due to time constraints at the end of each academic year, the students had to take the post-tests at the beginning of Year 8 and 9 respectively. The tests were marked by the respective Science teacher; I did a sample check and asked teachers to check with me any responses that they were not sure of. The students' test results were analysed to see if cognitive gains were above benchmark expectations. The benchmark data is held by Science Reasoning. Therefore they were commissioned to

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<sup>50</sup> This was the advice given by Denise Ginsburg at Science Reasoning.

produce detailed reports based on students' SRT scores. A more detailed summary of the development of SRTs (Shayer and Wylam 2001) and two recent reviews of the standardisation of the norms (SRT II - Shayer, Ginsburg & Coe 2007, SRT III and IV – Shayer & Ginsburg, 2009) can be found in appendix 5d.

## ***Part IX: PD Programme***

In the EPPI centre's first review (Cordingley et al., 2003), it was stated that a lack of methodological detail in the research papers was one of the main limitations to the inferences that could be drawn by the review group. As part of this lack of detail, they found confusion with respect to the procedures and/or research tools that were used for PD reasons and those that were used for research purposes: *'CPD processes and research processes were also sometimes confused; for example, it was sometimes difficult to ascertain whether observation was being used simply for data collection purposes or as an integral part of the CPD process (p6).'* This was an important issue and therefore clarity was given to the PD inputs.

### **PD Inputs**

Cordingley (2007), in the fourth review on the role of the specialist, found parity amongst the studies in terms of PD inputs used to promote change in the classroom. The main types of support included: modelling, workshops, observation, feedback, coaching and planned and informal meetings for discussion. These PD inputs match those advocated by Joyce and Showers (2002) in terms of the components of effective PD – theory, demonstrations, practice and coaching.

The different PD inputs that were employed were as follows:

- Questionnaires at the beginning of the research (appendix 7a); the participant teachers' responses can be found in appendix 7b;

- INSET sessions with the Science department using the BP INSET Pack (Adey 1993) and the Professional version of the Thinking Science CDrom (Adey et al., 2003); (appendix 8a –handouts, 8b –feedback from teachers, 8c –summary questionnaire);
- Demonstration lesson by CASE trainer (me) at the start of the year
- Teacher journals (appendix 9)

A description of each PD input can be found in appendix 6 and the resources can be found in appendices 7 to 9, which are also specified above. A calendar for the year can be found in appendix 10.

The reason why the initial questionnaires and feedback from participant teachers post INSET sessions were not included as evidence to help answer the research questions was partly to do with limiting the size of the thesis. In addition, as both sources were generally used by me as part of the PD process as my role as a trainer and coach, it was decided that the observation and interview methods were sufficient to collect data on the teachers' PD with the CASE methodology. Also by adding more methods to the approach, it would have added another layer of complexity to the comparability of findings.

## ***Part X: Validity***

This final part of this section begins with a short summary of the issue of the relevance of validity within qualitative research most notably case studies. The main part focuses on the steps that were taken at the different stages of the research to ensure that the findings relating to teacher processes and outcomes for the RBT would be judged as valid.<sup>51</sup>

### **Case Studies**

Yin discusses many of the criticisms related to case studies which he terms as traditional prejudices, where: *'case studies have been viewed as a less desirable form of inquiry than either experimental or surveys (p9).'* He connects this to the lack of rigour by researchers and the inability to generalise the findings to the population, making the point that they can, however, be generalised to theoretical propositions. In addition, the amount of time they can take and the type of lengthy data they can produce lead to historical criticisms compared with other methodologies. Stake (1978) acknowledges this, stating that a case study: *'proliferates rather than narrows (p7)'* and Stenhouse (1980) supports this noting that they are *'far more laborious (p3).'*

In response to the criticisms of generalising from a single case, Simons (1996) relates this to the need for certainty and comparability in social scientific research. In her paper titled *'The Paradox of Case Study'*, she posits that it is through studying the uniqueness of a given situation that our understanding becomes universal. This paradox is integral to the process of research where the tension for researchers between their understanding of the

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<sup>51</sup> The validity and reliability of the SRTs were considered separately in the Part V of this section.



individual case, and its application to the general population, creates an openness which allows for re-examination where: *'we eventually come to realise the significance of the event, instance or circumstance and the universal understanding it evokes (p231).'* The position taken is very much anti-positivist, which advocates the need for creativity, ambiguity and tension in order to understand and explore educational phenomena. Evers and Wu (2006) argue that generalisations are possible because the empirical knowledge produced from case studies comes from theories that are based on general terms and regulations, which are used by researchers in data collection and analysis. This, combined with the analytical tool of abduction, helps to reduce conformational bias which they define as: *'of seeing in the case whatever is brought to it in the theory (p522).'* Whilst the examples they use to support the conditions are at times rudimentary, using analogies which would not fit within the context of social scientific research, their epistemological procedure, of an ongoing trajectory of testing and re-examining theory, echoes Simon's (1996) conjecture regarding the paradoxical relationship between the unique and the universal.

### **Reliability**

With respect to reliability, researchers have argued that it is an unsuitable consideration for a qualitative researcher (Stenbacka, 2001). For example, Bassey (1999) posits that a case study is selected for its singularity and, as this is generally not a typical example or situation, it cannot be repeated. There are, however, qualitative researchers who have outlined the need to consider reliability (Yin, 1994) and /or steps that multiple researchers can take to improve the reliability of the methods and tools used (Cohen et al., 2007). The RBT took the position that reliability was not applicable, or worth further consideration

in relation to the tenets of naturalistic enquiry where the uniqueness is a strength rather than a weakness in terms of lack of replication (Cohen et al., 2007). In addition, Denzin and Lincoln's (1994) suggestion of inter-rater reliability was not possible because I was the sole researcher; this was considered in Part V in terms of a limitation to the research.

### **Validity**

Cresswell (1994) and Denzin (2002) both advocate that interpretation is central to qualitative research. Whilst validity is essential to the findings of quantitative research, its suitability to the judgements made about the quality of qualitative data is contentious (Maxwell 2002, Onwuegbuzie & Johnson, 2006). Silverman (2005) suggests that one of the reasons for the debate centres on the nature of 'truth' in research, which directly relates to validity in terms of what the data is actually trying to represent. Guba and Lincoln (1985) are two of the main exponents of the rejection of the use of validity, preferring authenticity, credibility and transferability. This position relates to an objection of positivist standards being used to judge the quality of qualitative research (Miller, Nelson & Moore, 1998). Cohen et al (2007) posit that validity can still be used and considered in qualitative research, but that it needs to be located within discussion on the research paradigm.

Whilst the debate certainly raises important themes for consideration, this part intends to outline issues of validity with respect to the RBT, preferring this term as opposed to others which are more aligned with a purely interpretive approach. In terms of the RBT's pragmatic paradigm, the relevant ones are Maxwell (2002) and Yin's descriptions of

validity, mainly because they both come from a realist perspective of qualitative research with respect to validity. To assess the quality of case study research, Yin (1994) suggests the use of the three conventional types of validity: *construct, internal and external* (p33); Maxwell (2002) posits that the most important types are *descriptive, interpretive and theoretical* (p55). They both centre on the validity of the data and give procedural advice about the stages involved in data collection, analysis, theory-building and the levels of abstraction involved at each stage. The different ways that the RBT addressed the issues of quality of the research are as follows, including references to Maxwell and Yin's types of validity:

- *The design of an analytical framework*

This showed how all the outcomes and processes were initially coded based on the constructs in the research questions, being structured using relevant literature especially CA research. This relates both to Yin's construct validity and Maxwell's theoretical validity. Yin's construct validity is associated with how the constructs are defined and measured; Maxwell's theoretical validity is more complex but: '*explicitly addresses the theoretical constructions that the researcher brings to, or develops during, the study* (p50).' There was an awareness from the beginning that the constructs would need to be refined as the research proceeded, which made it an iterative process (Eisenhardt, 2002, Miles & Huberman, 2002).

- *The use of mixed-methods*

The RBT used mixed-methods; two qualitative methods -interviews and observation- were conducted three times over the course of the research to address teacher processes and outcomes and SRT tests for student outcomes. As mentioned earlier, triangulation is a tool used to increase the validity of a phenomenon by using different methods (Greene et al., 1989, Cresswell, 1994,); this was used to consider the constructs of the process of change and teachers' sense of ownership, where both lesson observation and interviews were used to collect evidence. The use of mixed-methods relates to Yin's construct validity in terms of having multiple sources of evidence as well as having a chain of evidence.

- *The use of observation and interview schedules*

This relates to Maxwell's descriptive validity which centres on the factual accuracy of the evidence obtained by the two methods. In order to address this in relation to the data that was obtained from observing each teacher, the lesson observations were structured using the established observation schedule (Mbano, 2001); this was used for all lesson observation. It was not possible to video the lessons due to logistical and quality issues as well as cost implications. In relation to the data obtained from interviewing the teachers, the interviews were all recorded using a digital-voice recorder and the semi-structured approach allowed for flexibility and further exploration (Gherardi & Turner, 2002).

- *The processes used for data analysis*

Yin (1994) relates this to internal validity where attention needs to be given to the inferences that are drawn, including the analytical processes. The data analysis centred on the research questions and related constructs. It recognised that there needed to be an element of an inductive approach, which as mentioned earlier allowed a degree of flexibility with the research questions and related constructs which supported the internal validity (Eisenhardt, 2002). This helped to address the issue of conformational bias (Evers & Wu, 2006) where findings are solely focused on prior theory.

Data analysis through interpretation requires an additional level of abstraction compared with data collection; this relates to Maxwell's interpretive validity where the researcher constructs the interpretation of participants' actions and/or responses by attributing meaning to their accounts. Based on a pragmatic paradigm, Onwuegbuzie and Johnson (2006) advocate the need to address the problems associated with integration of data when using mixed-methods in data analysis. As already mentioned, the phenomena of the process of change and teachers' sense of ownership were considered through two data sources. There was an awareness of the different sources of the data in terms how they were integrated to represent the different phenomena; this was made explicit in the results section, in part by drawing upon the refinements made to the analytical framework.

There were numerous practical ways that the data collection and analysis stages were carried out to order to address the validity of the findings with several of them being outlined in the sub-part on the role of the researcher. Participants' validation of

interpretations (Cresswell, 1994, Cohen et al., 2007), termed '*member-checking*' by Stake (1995), was used for the analysis of the teachers' responses to the semi-structured interviews which were initially analysed separately. This relates to Denzin's (2002) conjecture that it is unacceptable if the interpretations made by a researcher do not make sense to the subject(s).

Based on his concerns about the use of anecdotalism in qualitative data analysis, Silverman's (2005) recommends the use of other inter-related techniques to make findings more valid. The most relevant to the RBT were *the refutability principle* and *the constant comparative method*. The former is to think critically about relationships between constructs and not to jump to the easiest conclusions. The latter relates to having other cases to compare and test judgements; this was partly achieved through treating initially each teacher separately in the analysis of each question so that the conclusions that were drawn recognised both similarities and differences. In addition, Silverman (2005) also suggests *comprehensive data treatment* and *deviant-case analysis* where all data is incorporated into the data analysis and that cases that do not fit are also explored and reported upon. This advice was used so that all parts of the transcripts and lesson observations were analysed and inconsistencies as well as unexpected findings were explored.

- *The usefulness of the findings*

For case studies, the ability to generalise findings (Evers & Wu, 2006) relates to their external validity (Yin, 1994) which centres on theoretical application rather than to the

wider population (McCutcheon, 1981). Stake (1995) posits that the findings of case studies are about particularisation rather than generalisation, regarding the interpretation of the evidence of a particular case.

The RBT took the position advocated by Lincoln and Guba (2002) of transferability where the reader is able to draw inferences about the findings to his/her own situation; in order for this to happen, there must be sufficient detail and clarity of meaning about the context of the research; the reader learns in some way from the product of the research and therefore the findings are applicable. This is echoed by Schofield (2002) in terms of a 'fit' between the findings and the interests of others in applying them. The RBT dealt with this through an in-depth literature review which highlighted important theoretical considerations; in addition, a detailed methodology and methods sections made the context explicit, including the methods used for data collection as well as the inputs employed for PD purposes. Therefore, as mentioned in the introduction to the RBT, the intention was that the findings of the RBT would be useful to schools embarking on implementing the CASE project and/or dealing with the issue of longevity.

In summary, this part has addressed the important issue of the quality of the findings of the RBT through a consideration of the research stages and the relevance of its findings. The next part builds on the validity of the findings by focusing on the role of the researcher, in particular multiple roles and possible biases.

## **Researcher's role**

In the EPPI centre review on the role of the specialist (Cordingley et al., 2007), it was reported that it was the researchers who generally ran the PD programmes and therefore they lacked a degree of control to deal with potential biases. This part outlines for the RBT some of the ways that potential biases between researcher and participant teachers were addressed.

It was decided that it was important to stress to the participant teachers at every possible opportunity that the research linked in no way to my leadership role within the school and that the research would not be discussed with any colleagues. Also the boundaries between PD inputs, methods for data collection as well my role in school had to have a clear demarcation. This part addresses some of the ways the RBT addressed possible biases in terms of their possible threat to the validity of the research findings. The sources were taken from Cohen et al (2007) in terms of how to ensure validity.

### **Data Collection**

- *Minimise reactivity effects*

I recognised that the participant teachers could respond differently because of the new situations they found themselves in and made notes in my journal if I thought this had been the case. I made a concerted effort to make the semi-structured interviews like a conversation (Kvale, 1996) and asked probing questions in part to show my interest and attention to their responses. In the lesson observations, I remained at the back as much as possible other than walking around to listen to group discussion. I was always



encouraging after the lesson, thanking the participant teachers for allowing me to observe, and saying that I looked forward to providing feedback at a mutually convenient time.

- *Avoid drop out from respondents*

The three participant teachers showed an excellent commitment to the PD programme and research. I made sure that their level of involvement was outlined in advance, including ethical issues that related to the research, especially regarding anonymity.

- *Build upon the motivations of the respondents*

I added to the lesson observation schedule, strengths and recommendations. I made sure throughout the observation to note down specific points in terms of strengths and not suggest too many recommendations so that they had a realistic number of things to build upon. In addition, during the interviews I tried to use many positive and encouraging remarks.

### **Data analysis**

- *Reduce the halo effect*

The advantages noted in relation to insider knowledge (Arksey & Knight, 1999) can be seen as a possible bias; this was very important in the data analysis in terms of making sure that judgements were not based on prior knowledge of the individuals. This was partly addressed by the analysis being focused on the transcripts and lesson observation and through using participant validation of my interpretations.

In summary, whilst it is common practice in PD research for specialists also to be the researchers, the RBT involved me also being an insider researcher. On one level this was advantageous in terms of gaining entry and understanding established procedures. There were, however, numerous possible biases which were considered in advance so as to try to minimise their effect on the validity of the findings.

## Section IV: Results

This section is separated into two parts in terms of the research questions:

- Part I            *analysis of the teacher data in relation to the two teacher-related research questions*
- Part II           *analysis of the student data in relation to the one student-related research question*

### ***Part I: Teacher Interviews and Lesson Observations***

*This part is separated into a commentary of the results in relation to each research question, including a comparison of all three teachers based on both questions.*

#### **Research Question 1**

- *How does a teacher change in terms of his/her classroom skills, attitudes/beliefs and knowledge/understanding of the theoretical underpinnings of CASE as he/she develops an ownership of the methodology and how can the nature of the change process be characterised? ( Question 1)*

The construct of classroom skills was considered using the lesson observations, whilst attitude & beliefs and knowledge & understanding were based on participants' responses in the three semi-structured interviews. The overall summary for all teachers considers the evidence in relation to how each teacher changed as he/she developed a sense of ownership with the CASE methodology and the how the change process could be characterised; as previously mentioned, the latter drew upon evidence obtained from both lesson observations as well as self-reported data from interviews. Sense of ownership

(SoO), as outlined in Section III, was based on Mevarech's U-curve model (1995) as it allowed for a holistic description of teachers' development.

### Teacher A

- *Classroom Skills*<sup>52</sup>

**First observation:** The lesson plan was followed step-by-step and there was evidence that an enormous amount of time and effort had been put into preparing the lesson (LO1(S):b). The strengths of the lesson in the observation schedule recognised the organisation of the lesson (LO1(S):d). The timing part of the observation schedule emphasised the amount of time spent on the pillars of construction and conflict (appendix 3a(i)), which I commented on as a strength in terms of her '*allowing students to articulate their reasoning*' (LO2(S):c). The students were questioned throughout the lesson, but Teacher A moved the discussion on, at times, too quickly and gave one very bright student, H, too many opportunities to speak during the class discussion (LO1(R):c). Her questioning technique indicated that the teacher was keen to move on once one or two students had given the 'correct' answer, rather than probing other students to see whether they agreed or disagreed (LO1(R):b). In the schedule, the pillars of metacognition and bridging were hardly evident throughout the whole lesson, with only one cross on the observation schedule (appendix 3a(i)) next to other metacognitive activities. Teacher A struggled, but did cope, during the last part of the lesson, where she had to do a demonstration of heating oil which was technically quite challenging to do at the same time as maintaining the group's cognitive engagement with the activity (LO1(S): e).

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<sup>52</sup> As mentioned in Section III, each teacher was observed once a term.

**Overall judgement: low Level 2-** *A weak advanced beginner: displaying mechanical use of the methodology beyond a novice especially in terms of pillars of construction and cognitive conflict. Therefore experience was affecting behaviour, but there was still a lack of clarity about what was important especially during class discussion.*

**Second observation:** The list of strengths in the observation schedule reflected the fluidity of the lesson. It ran extremely smoothly, which was partly due to the bespoke PowerPoint presentation; students' names were put up on the slides to make sure that all students were asked at least one question (LO2(S):b). The data collection part took a very short time which allowed more time for class discussion (LO2(S):d); this was supported by the time spent on different pillars with less time on concrete preparation compared with the first observation and more time on construction and cognitive conflict, including more variation in type of activity (appendix 3a (ii)). In addition, there was an increase in the pillars of metacognition and bridging. Teacher A was clear as to her role as a facilitator and mediator of the students' conflict and resolution which was evident in her questioning skills, including not letting students know her position to their respective responses (LO2(S):c&h). In terms of adapting the lessons, this was based on recommendations from previous INSET discussion; she created conflict straightaway using her own stimulus (LO2(S):e) which showed she didn't need to follow the lesson plan in a rigid way, including the ordering of the pillars. In addition, she showed she was able to adapt during class discussion (LO2(S):f), but struggled to keep the focus going towards the end of the lesson when the discussion went off at a tangent (LO2(R):b) and there was a lack of focus on the reasoning pattern (LO2(R):e).

**Overall judgement: high level 3-** *A strong competent practitioner: showing highly effective routine use, but still struggling to use alternative strategies, unless previously recommended, or intuitive processes. The need for the PowerPoint presentation, whilst it helped the lesson to run smoothly, showed the need for Teacher A to be structured and deliberative in all her actions.*

**Third observation:** The list of strengths reflected how well the lesson went in terms of students experiencing conflict as well as being able, through small and whole class discussion, to begin to construct, through social means, an understanding of the reasoning pattern (LS3(S):a-j). There was evidence that she had spent an enormous amount of time on preparing the lesson, but she wasn't as deliberate with the students in terms of who would answer specific questions (LO3(S):c). Teacher A showed a holistic approach and was able to adapt throughout the lesson in relation to the different cognitive activities (LO3(S):f,&g) and was intuitive in her questioning of students in terms of pattern recognition, especially when dealing with the challenging mathematical formula of combinations (LO3(S):d,h,i). An area for development was still the pillar of metacognition (LO3(R):c).

**Overall judgement: low level 4-** *A fairly proficient practitioner: showing an integrated use by balancing most aspects of the CASE methodology and intuitively focusing on students' conflict and construction. The cognitive activity of metacognition was still an area for development.*

**Summary:** Teacher A showed a progression in her classroom practice from a low level two to a low level four over the course of the academic year. This progression reflected a change from mechanical behaviour to an integrated approach in relation to all aspects of the CASE methodology. Her intuitive behaviour was evident in the last lesson in terms of how quickly and fluidly she reacted to students' responses. Her bespoke PowerPoint presentations were used in all three observations, but in a more deliberative, less structural way in terms of relating it to the different cognitive activities. She was not judged as an expert as she was still analytic and deliberate in terms of her actions.

- *Knowledge and Understanding (K&U)*

In the analysis of the transcripts, twelve responses were interpreted as being associated with knowledge and understanding and were subsequently categorised into three themes. Firstly, the relationship between theory and practice was mentioned in her first and second interviews where she stated that she thought she understood, but only when she had to put it into practice, essentially testing her understanding, did she realise how much she still had to learn (K&U:2,7). Secondly, Teacher A reported that her knowledge and understanding of the CASE methodology had developed over the course of the year (K&U:10,12); in the first interview she referred to her understanding of the methodology, implicitly or explicitly, being developed through the different mediating factors, with modelling being mentioned specifically three times and classroom practice twice (K&U:1-7). In addition, her answers suggested that it was the application of the psychological models to the methodology, not her understanding of the actual models, that had changed as a result of the different mediating factors, whose respective influence

is considered in the next question. This was reflected in her comment in her last interview, when being asked about whether her understanding of the theory had developed, she stated that: *“I think that’s always been, because I’m very interested in pedagogy in general and I think from uni I’ve always, I’ve understood the theory, it’s more about how to teach and how the students actually progress with that. So for me this was, in a year I feel like I’ve managed to for the first time put that into practice and really see some results.”* (K&U:11).

Finally, in the second interview she referred to applying the methodology to her practice in normal lessons, especially using metacognition (K&U:8) and she was able to consider students’ cognitive skills in relation to the skills they need for the curriculum, most notably 21<sup>st</sup> Century Science at KS 4 (K&U:9).

- *Attitude & Beliefs (A&B)*

In the analysis of the transcripts, nine responses were interpreted as being associated with attitude and beliefs and were subsequently categorised into three themes. Firstly, Teacher A referred to her confidence changing in all three interviews, which she related to her understanding of the methodology (A&B:2,3,4,5,7). Her confidence showed a progression. For example, in the first interview she emphasised the mechanical aspects of the lessons, where she needed to know the lesson and felt confident only with the basic parts (A&B:2&3). By the last interview, she mentioned that her confidence with the lesson plan, as well as practical aspects, had allowed her to focus more on the cognitive activities (A&B:9). In addition, when asked in the last interview if she would feel comfortable to be observed by other teachers, she responded that she would because of



the progress she had made through lesson observation combined with feedback (A&B: 8). Secondly in terms of her beliefs, in her last interview she stated a change from multiple intelligences, which she had previously been ‘into’, to the CASE psychological model which she said was because of seeing the way that the students responded to challenge (A&B:6). She indicated that a change in her belief, regarding how students learn and develop, had happened because of experiencing firsthand students’ responses to the methodology. Finally in terms of how she felt about the PD, in the first interview she referred to feeling uncomfortable when being asked a follow-up question regarding teachers being active participants of INSET sessions, making the following comment: *“we should be uncomfortable, we should be in cognitive conflict, which I really was not looking forward to, to be honest, in that first session. But I was expecting it somewhat and when it was happening I wasn’t comfortable but as I’m going through this process I’ve been, just the benefit of it, you know you see it with the students and so I think with staff it’s, we have to be able to do that to even somewhat understand what it’s like for them but also to be able to achieve the goals of what we’re trying to do.”* (A&B:1)

Her comment (A&B:1) related to her expectation that the process would be challenging and aligned this with students’ experience with CASE.

Overall, Teacher A developed in all three areas over the course of the year. Firstly, in terms of her classroom skills she was judged by me to have improved from an advanced beginner to a proficient practitioner. Secondly, she reported being more confident with the methodology and that her view on learning had changed partly because of how the students responded to conflict. She commented that the learning experience had made her

feel uncomfortable. With respect to her understanding, she noted that it had increased in terms of the CASE methodology rather than of the psychological models that underpin the project. In terms of applying Mevarech's model to developing a sense of ownership (SoO), for Teacher A the model would indicate that there was a change from level 1 and 2 of surviving and exploring/bridging during the first term through to a conceptual change at level 4 by the last term. This change was characterised by her struggling to cope with all the different aspects of the lesson and her initial mechanical use of the methodology, which she described as 'concrete'. Once she felt confident with the technical aspects, she stated that she was able to focus on the cognitive activities, which would reflect a change from level 2 to level 3 the adaptation stage. Her classroom skills in the third observation combined with her reported beliefs about learning partly because of how the students responded to the lessons, as well as an improved understanding of the methodology, would indicate she had developed a SoO that related to level 4, a conceptual change.

### **Teacher B**

- *Classroom skills*

**First observation:** The lesson plan was followed in order of proposed activities, but a bespoke PowerPoint presentation showed some adaptation in terms of original ideas (LO1(S):a,c,d). Teacher B showed good discussion techniques (LO1(S):b), for example, getting one student to give another one advice (LO1(S):e). A major problem with the lesson was the lack of social mediation as Teacher B never gave the students an opportunity to discuss their ideas with one another (LO1(R):a). There was very little variation in type of cognitive activity with no bridging of the reasoning pattern and very

little metacognition (appendix 3b(i)). The list of recommendations gave specific advice on all the key cognitive activities (LO1(R):a,c,d,g,h). For example, *the pillar of bridging: can you think of another variable – what are its values?* (LO1(R):h).

**Overall judgement: low Level 2-** *A weak advanced beginner: displaying mechanical use of the methodology just beyond a novice in terms of some original ideas and his questioning of students; there was a serious issue in terms of lack of social construction.*

**Second observation:** The lesson showed more variation in the different cognitive activities where time was spent on bridging and metacognition at the beginning of the lesson (appendix 3b(ii)). The use of an opening ‘catch’ engaged the students, which reflected his ability to adapt the lesson, using different examples (LO2(S):a) as well as another example on vertebrates which created a lot of discussion (LO2(S):b) among the students. There was a notable difference in relation to social construction with his approach showing all aspects of the CASE methodology (LO2(S):e), including using techniques such as getting the students to vote to agree a consensus before moving on (LO2(S):c). The main recommendation centred on timings as too much time was spent on the opening discussion (LO2(R):a) and therefore specific advice was given (LO2(R):b,c,d). In addition, he was again given questions to encourage metacognition especially after social construction (LO2(R):f).

**Overall judgement: level 3-** *A competent practitioner: showing routine use and an ability to adapt resources. He clearly knew what to focus on, but lacked the use of additional strategies, unless previously recommended. In addition, timing was too slow which would have related to conscious rather than intuitive processes.*

**Third observation:** The lesson had a clear structure where the development in his questioning skills was reflected in him asking students to give evidence to support their responses (LO3(S):d). There was an improvement in relation to Teacher B interjecting to move the discussion on (LO3(S):c). At the end of the lesson, there was a focus on bridging the reasoning pattern to other contexts which was very successful in terms of getting students to write down their own suggestion before sharing with the class (LO3(S):f). The recommendations focused again on timing, where the ‘number-crunching’ part of the lesson had taken too long (LO3(R):b,c), which reduced the time for the plenary (LO3(R):d). There was no indication in the lesson of metacognition (LO3(R):g).

**Overall judgement: high level 3-** *A very competent practitioner: showing again a frequent use of strategies that have been effective with an improvement on the cognitive skill of bridging and getting students to provide evidence to support their reasoning. Timing continued to be an issue which was mainly because he was unable to use alternative strategies to move the lesson on.*

**Summary:** Teacher B showed a progression in his classroom skills from a low level two to a high level 3. He changed considerably from the first to the second in relation to social mediation and a confidence to adapt the lessons. His questioning skills became more focused on the cognitive activities and he was clearly more deliberate in his actions. He did not, however, show intuition or the ability to use alternative strategies; these are prominent characteristics of the proficient stage.

- *Knowledge and Understanding*

The fifteen responses that related to knowledge and understanding were categorised into the same three themes as Teacher A. Firstly in relation to practice and theory, Teacher B repeatedly emphasised the importance of the practical side over the theory (K&U 1,2,8,10,12). He stated that he knew the basics from his PGCE (Postgraduate Certificate in Education) course (K&U:1), but he needed to focus on the practical side of things and then the theory behind it (K&U:2). His responses in the second and third interviews were contradictory; in the second interview he mentioned that the theory is important at the beginning, whereas in the last interview he commented that: *'I don't need to know loads and loads of information about you know the background of where it's come from, the history of it (K&U:10).'* Secondly regarding whether he had gained knowledge, he responded that it had, but his answer focused solely on the methodology (K&U:12). There were several comments throughout all three interviews that related explicitly or implicitly to his knowledge of the methodology and purpose of CASE (K&U 3-7,9,11,13-15). In the first interview he stated that he was thinking now more about the purpose behind the lesson, which had affected his classroom practice. He commented in the last interview that the practical side needed to run smoothly to make sure there was enough time for other cognitive activities. There were never any comments that specifically referred to the actual psychological models that underpin the project. Lastly in line with Teacher A, he was applying his knowledge of the methodology in other lessons, emphasising it in terms of: *"passing it back to them and the questioning and*

*involving the class and not just telling them the answer, that's definitely come from CASE (K&U:5)."*

- *Attitude & Beliefs*

The nineteen responses that related to attitude and beliefs were categorised into three themes, which were aligned with Teacher A's. Firstly in relation to confidence, in the first interview he noted a confidence in his ability to carry out the lessons and to adapt them (A&B:1,3). By the final interview, he noted a progression where initially he had been nervous, but now he had confidence in his skills (A&B:16,17,19) and in the students (A&B:19) in terms of handing it over to them (A&B:18). Secondly regarding his beliefs and views, he stated that his view on learning had not changed (A&B:14); he focused on students' conflict which he believes happens in their minds (A&B:2) and that he holds the CASE project in high regard (A&B:6) because it relates to challenging students' misconceptions (A&B:14 &15). He stated clear opinions on the role of the teacher in terms of types of responses (A&B:10) and thought that most teachers would prefer structured lessons over the flexible approach needed with CASE (A&B:11). Lastly, he made several references about how the process made him feel. He noted in the first interview that his teaching was getting a '*bit stale*' and was pleased with the challenge (A&B:5) and that everyone struggles to start in terms of handing it over to the students (A&B:4); he also felt he wasn't doing the lessons justice and that he had a lot to learn (A&B:7). He stated he found some Year 8 lessons difficult (A&B:8), recalling one lesson when he was in a '*cold sweat*' (A&B:9). In the last interview, he commented that he was pleased with the progress he had made which was different to his expectations (A&B:13),

but with respect to putting the practical side above theory he stated that: *“I don’t know if that’s a, maybe that’s a weakness I don’t know, it’s just my feeling on it (A&B:12).”*

Overall, Teacher B developed in all three areas over the course of the year. Firstly, in terms of his classroom skills he was judged by me to have improved from an advanced beginner to a highly competent practitioner. Secondly, he reported being more confident with the methodology and that his view on learning had not changed, focusing on the challenging students’ misconceptions. He noted several difficulties during the first interview relating to feeling nervous and struggling in lessons, especially when the discussion went off at a tangent. With respect to his understanding, he consistently emphasised the practical side and therefore his answers referred to the CASE methodology; he did not once mention the psychological models that underpin CASE. In terms of applying Mevarech’s model to developing a SoO, for Teacher B the model would indicate that there was a change from level 1 and 2 of surviving and exploring/bridging during the first term through to adaptation at level 3 by the second and third term. This change was characterised by his initial rigid use of the teacher’s guidelines, but with some exploring in terms of a ‘catch’ at the start of the lesson. In the first interview, he noted that he was more critical of the lessons and was trying to tailor them to his own style of teaching. He commented that everyone struggles to begin with, but that confidence helps teachers to be able to adapt the lessons. The comments made in the second and third interviews reflect a stabilisation at the adaptation level 3, where he was able to reflect on the innovation, his planning related to the cognitive activities and his focus was on the students. His classroom skills in the third observation combined with

his self-reported data would indicate he had developed a SoO that related to level 3, an adaptation. The main reason that his SoO had not developed beyond this level was his lack of engagement in the psychological models that underpin the CASE project, which characterises the level 4, conceptual change.

### **Teacher C**

- *Classroom skills*

**First observation:** The lesson showed a skilled use of the CASE methodology, where her wealth of experience was reflected in her effective questioning skills (LO1(S):d) as well as her attempt to involve all students in the lessons (LO1(S):b). Her experience showed in terms of a clarity about the task, which allowed her to respond easily to students' comments (LO1(S):e). In the plenary she encouraged students to bridge the reasoning pattern to other contexts (LO1(S):e), which was reflected in time spent on bridging in the lesson observation schedule (appendix 3c(i)). The main recommendations focused on the pace of the lesson (LO1(R):d); in addition, specific advice was given in terms of questions that encourage students to metacognise (LO1(R):e) even though this had been recorded on the observation schedule on three separate time periods (appendix 3c(i)).

**Overall judgement: low level 4-** *A fairly proficient practitioner: showing an integrated use by balancing all aspects of the CASE methodology and intuitively focusing on students' answers. The main area for development was the pace of the lesson which was partly because she was still analytic and deliberative in deciding how to proceed from one activity to another.*



**Second observation:** The lesson showed an integrated use of the methodology especially in terms of how the different pillars were maintained during the whole class plenary (appendix 3c(ii)). The list of strengths reflected her ability to create conflict (LO2(S):c,f), to use bridging examples (LO2(S):b) and to involve all groups in the whole class discussion (LO2(S):e). Her questioning was more focused on the pillars and reflected her ability to use effectively strategies that have worked before (LO2(S):a,c,f). There was the same recommendation given in terms of pace (LO2(R):a) as well as some logistical issues.

**Overall judgement: level 4** –*A proficient practitioner: showing the same characteristics as before in terms of a holistic approach and the ability to balance the different pillars at the end of the main activity. In this lesson she showed a more effective use of questioning in relation to the pillars, which was reflected in the slight improvement in the overall judgement. The recommendation reflected that she was still analytic and deliberative in her actions.*

**Third observation<sup>53</sup>:** The lesson showed a holistic approach which allowed students to construct their ideas in small group and whole class discussion (LO3(S):b,c). She showed advanced questioning skills in maintaining the cognitive activities (LO3(S): e) and there was an improvement from the first two observations in terms of ensuring the task was understood by everyone (LO3(S):a). Her experience and intuitive responses allowed her to remain very flexible during whole class discussion where she was open to all

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<sup>53</sup> Appendix 3c(iii) the timing part is not completed; this was because this information got accidentally deleted in transferring files.

comments and responded effortlessly, using effective pattern recognition (LO3(S):e). The main recommendation focused again on timing (LO3(R):a).

**Overall judgement: level 4** –*A proficient practitioner: showing the same characteristics as before in terms of a flexible and intuitive approach, but still needing to address timing in lessons.*

**Summary:** Teacher C showed in all three observed lessons that she was a proficient CASE practitioner. There was some progress in terms of fine-tuning certain skills such as timing and clarity of the task during concrete preparation. Her experience of CASE was evident in the way she managed activities and how she was able to foresee events. Her intuition was clearly reflected in her effective questioning of students as well as her ability fluidly to facilitate the different cognitive activities. The lessons were not judged as expert mainly because of the lack of pace which indicated that she was still analytic and deliberate in deciding upon her actions.

- *Knowledge & Understanding*

The eighteen responses that related to knowledge and understanding were categorised into the same three themes as Teachers A and B. Firstly in terms of the relationship between theory and practice, Teacher C consistently maintained throughout all three interviews her position that it is the understanding of the pedagogy that informs and affects practice. Through understanding the purpose of lessons (K&U:1,15), it affects a teacher's ability to adapt lessons (K&U:2,3,8); she related this to a beginner teacher using the guide like a recipe because of his/her lack of knowledge (K&U:11) and the amount

going on in a lesson (K&U:12). She noted specific parts of the pedagogy that are more straightforward to understand such as social mediation (K&U:13), but was clear that it must come before practice, which allows teachers to start to adapt: *“I think if you’re new to it you need to have an idea of the pedagogy before you even start looking at the lessons because they don’t necessarily make sense. But once you’ve had that introduction to the pedagogy I think then you can link the 2 together ...But I think the pedagogy needs to be there first before people can start to say “well let’s chop that bit out it doesn’t matter* (K&U:14).” Secondly, in relation to whether her knowledge had increased during the year, she stated that it hadn’t in terms of the pedagogy (K&U:17) as she had also covered more in her MA (K&U:6), but that it had been good to recap (K&U:7,9). She commented that it had given her time to reflect on the methodology in terms of the specific activities (K&U:5). She stated that her knowledge had increased through experience, reducing her planning time (K&U:4) and that her intuition had developed through doing the lessons so many times (K&U:18). Finally, in terms of applying the methodology, she stated that she had been doing it mainly at KS3, focusing on conflict (K&U:16) and also had been considering students’ motivation in relation to conflict (K&U:10).

- *Attitude & Beliefs*

The six responses that related to attitude and beliefs were categorised into the same three themes as Teachers A and B. Firstly in terms of confidence, she stated in the first interview that she had the confidence to adapt lessons because she knows the purpose (A&B:1) and she didn’t think there had been any changes after the first term because she was already: *“quite confident and aware of what’s going on anyway* (A&B:3).” In terms

of her views on learning, she stated that they hadn't changed, that CASE always been there (A&B:5), but it has always good to recap pedagogy (A&B:2). Lastly, the only difficulty she alluded to was working with students she didn't know at the beginning of the academic year (A&B:6) and very much advocated the need for a supportive environment for PD especially when things go wrong (A&B:4).

Overall, Teacher C did not change very much in terms of her classroom skills being judged as a proficient practitioner in all three observations; she did, however, show a slight refinement of skills from the first to the second observation. In all three interviews she maintained that she had not changed in terms of her knowledge and understanding, confidence or beliefs on learning throughout the course of the year, which she related to her experience. In terms of applying Mevarech's model to developing a sense of ownership (SoO), for Teacher C the model would indicate that there was a change from level 4, conceptual change, to level 5, invention, by the last term. Her strong emphasis on teachers understanding the pedagogy to be able to know the purpose of the activities was mentioned in all three interviews, which reflects level 4. She did, however, mention technical issues as an area to overcome; whilst this is not reflective of this stage, it was discussed in terms of how to adapt and deal with practical issues rather than as a main focus. In the first interview, she mentioned how she wanted to devise curriculum activities based on the CASE methodology, alluding to trying it out at KS 3 in the first interview. In the last interview, after attending the CA convention, she stated that she was devising activities for the new Year 7 curriculum based on the CASE methodology which reflects the level 5 stage.

### **Comparison of three teachers**

In relation to the classroom skills, both Teachers A and B were judged to have improved from advanced beginners to a proficient practitioner and a competent practitioner respectively. Teacher C was judged to be a proficient practitioner in all three observations, but there was some refinement of skills. Secondly, through their responses all three teachers separated their knowledge and understanding, into either the psychological models that underpin CASE or its methodology in relation to classroom practice. For Teacher A, it was her understanding of the methodology that increased rather than the psychological models. For Teacher B, there was a development in his knowledge and understanding of the methodology, but with no indication of a change with respect to the psychological models. Teacher C stated consistently that she thought an understanding of the psychological model was essential to the methodology both for adaptation and application, but noted that there had not been a personal change during the research year. Finally with respect to attitudes and beliefs, Teacher C reported being confident at the start of the year whereas the least experienced Teachers, A and B, reported changes in their respective confidence over the course of the year; this related to an improvement in classroom practice especially through a reduced focus on the technical side which allowed for a greater emphasis on the cognitive aims of the lesson. Teacher B and C stated that their views on learning had not changed, having both been introduced to the CASE pedagogy during their PGCE course at King's College, London. On the other hand, Teacher C, who was trained in Australia, noted a change from multiple intelligences to the CASE methodology, relating it partly to seeing how students

responded to the CASE methodology. Teachers A and B both reported difficulties during the first term, which Teacher A related to the learning experience and Teacher B to struggling with class discussion. Teacher C noted that she found CASE more difficult at the beginning of the year when she didn't know the students.

Finally in terms of how this evidence helps to answer the part of the question regarding the nature of the change process, both Teacher A and B's progress would tentatively indicate that the process of change is not uniform, but that there was not enough evidence to consider how it could be characterised in terms of whether it is a revolutionary or evolutionary process. Teacher A had the least experience with CASE at the start of the year; based on her lesson observations, however, she had made more progress than Teacher B by the end of the research year. In addition, when considering her SoO, her engagement with the methodology and students' learning indicated a higher level compared with Teacher B whose emphasis was on the practical side as opposed the theoretical underpinnings of CASE. Teacher A's development in terms of her classroom practice and SoO would indicate that the PD of teachers with CASE could take less time than the recommended two years. Therefore whilst Teacher A's progress could be described as accelerated compared with Teacher B's, there is insufficient evidence to base a judgement on in relation to the nature of the change process.

## Research Question II

- *How important to the process of change are the mediating factors of experimentation, collaboration, lesson observation with feedback and modelling?*  
( Question 2)

The four mediating factors and the process of change are considered separately for each teacher. The evidence is based on their responses to the questions during the three semi-structured interviews. This part ends with a comparison of the three teachers.

### Teacher A

- *Experimentation (planning and teaching CASE)*

In the analysis of the transcripts, thirteen responses were interpreted as being associated with experimentation and were subsequently categorised into two themes. Firstly in terms of the use of the approach and progression, Teacher A mentioned in her first interview that she followed the teacher's guide like a manual (E:6), but wanted to adapt (E:5), which she noted during a lesson was virtually impossible (E:7). By the second interview, she noted that she was using ICT in lessons which she stated would have been helpful at the beginning, but acknowledged that possibly there was too much to focus on at the start (E:11,12); this connects to her lack of use of students' SRT data, which was discussed in the first interview (E:2). The time taken to plan lessons was mentioned in both the first and last interviews (E:1,13), which she related to pressure and in the last interview specifically to the question about any negative aspects to the year.

Secondly in relation to specific aspects of the methodology, Teacher A repeatedly focused on how to respond to students' comments in class discussion as well as how to ensure each student experienced conflict (E:3,4,8,9). In the first interview, she was focusing on this and noted it as a difficulty (E:3). Her comment in the first interview, regarding her speed of response, showed that she had developed a strategy in order to try to cope with her inability to respond quickly:

*“But yeah I think I was thinking a lot about their thinking and that for me was becoming a bit too much, at the same time thinking about how to respond to their responses. That’s a real art that I think. And I think also it’s a very, it’s like a comprehension ability that I would have to develop stronger to be able to, I think in any lesson when a student gives me an answer to think on my feet fast to give back. I often ask them to repeat it.”* (E:8)

In the second interview, she stated there had been an improvement in her dialogue with students (E:9), but noted that she had to have the questioning ‘*programmed*’ otherwise she would have reverted to her ‘*habits*’ in normal lessons (E:10); this was supported by the lesson observation schedule (appendix 3a(ii)).

- *Collaboration*

In the analysis of the transcripts, eight responses were interpreted as being associated with collaboration through the INSET session and were subsequently categorised into one broad area in terms of approach and usefulness. In terms of the approach, Teacher A commented positively about teachers being active in the sessions, referring specifically to an activity where I asked them to consider the reasoning patterns that applied to a scientific concept they had taught that day (C:1); when asked a probing question she noted that it was good for teachers to be ‘*practical*’ and discuss what they have been doing in lessons (C:2). She noted, however, that this made her feel uncomfortable (C:3).



She stated she had written down and used questions that I had mentioned in relation to metacognitive questioning, which was part of the session led by me (C:5), and had found watching clips useful in terms of the pillars (C:4). When being asked about the usefulness of the INSET sessions in the last interview, she responded that whilst the part at the beginning which involved feedback by colleagues was good (C:6), she was more of a one-to-one person and therefore comments by teachers who hadn't been observed were '*less weighty*' (C:7), placing more emphasis on what I said during INSET sessions (C:8).

- *Lesson observations and feedback (coaching)*

The seventeen responses that related to lesson observation combined with feedback were categorised into three themes. Firstly, she explicitly referred to the importance of the lesson observation and feedback throughout all three interviews (O:1,7,11,12,16,17), using the expression that it had made a '*massive difference*' (O:1) and it had improved her teaching '*dramatically*' (O:11). The second was that she used the three observations as evidence of her progress (O:2,4,10,13,15). For example, she stated that in the first observation lesson she was in conflict (O:3), and that the lesson '*went badly*' (O:4), partly because of the difficulty of doing a practical demonstration whilst trying to maintain the students' thinking (O:5); when being asked in the last interview about her progress as a CASE teacher in terms of her delivery, she solely answered by comparing the three observations and did not refer to any other lessons or PD inputs (O:10). In addition, when asked about how the process of feedback could be improved, she suggested that it would be helpful if some indication of progress was given, saying: '*yes you hit that in that lesson out of 1-5*' (O:15). Finally, with respect to the type of advice, she had found the

strengths and recommendations useful, especially specific details (O:6,9,14), emphasising the importance of the one-to-one approach (O:7) and the need for someone to have expertise with CASE (O:8,13). She did not refer, however, to time spent on the different cognitive activities (O:14).

- *Modelling*

The fifteen responses that related to modelling were categorised into two themes. Firstly, Teacher A referred to the demonstration lesson, which she watched before her first observation, as modelling the methodology (M:1,7) and noted that she preferred it to the videos that were shown in the INSETs (M: 8). Secondly, in relation to its importance, her responses showed a level of ambiguity. In all three interviews, she noted the positive aspects of modelling (M:1,4,7,9,11-15) in terms of its usefulness in relation to the methodology and her development. In the first interview, however, she made the point that it is easier to watch than to do (M:2) which relates to the difficulty of putting it into practice (M:2). In addition, in the first and second interviews, she stated that there was too much going on in the demonstration lesson (M:5,10,11) which had caused conflict for her (M:3), but that she would benefit from watching another demonstration lesson (M:6).

- *Process of Change (PoC)*

The nineteen parts of the three interview transcripts that were analysed in relation to the PoC were categorised into three themes. In terms of the process of learning, six related to her reflecting (PoC:1,2,6,8,9,10) on the methodology, five to her struggling and/or being in conflict (PoC:4,5,7,8,12) and one to her using concrete preparation (PoC:3) in terms of the use of the terminology. With respect to how the process was brought about by the

different mediating factors of lesson observation with feedback and the demonstration lesson, she referred to the specific advice that informed future planning (PoC:11,13,15) and the need to see the methodology in its entirety (PoC:8), which allowed for '*scaffolding*.' (PoC:14). Lastly, in the third interview she made three comments that alluded to teachers being made aware of the whole experience at the beginning, which she stated was all about 'thinking' and that a teacher should be given some indication of progress (PoC:16,17,18,19).

In summary, based on analysis of the different mediating factors, Teacher A's responses indicated that she placed the most importance on lesson observation and feedback. The factor of experimentation was clearly an important part of the process, especially in terms of considering how to cope with all the different aspects of the lesson. She placed great emphasis on her ability to respond effectively to students' comments and to facilitate the cognitive activities on an individual level. The one demonstration lesson was clearly important in terms of seeing the methodology in its entirety, but its timing at the beginning of the process may have led to her comments about there being too much to take in. Her responses indicated that the mediating factor of least importance was collaboration through INSET session; in terms of working with others in the sessions, she placed more value on my input as a trainer compared with the opinions of other CASE teachers. In relation to the PoC, she referred to her experience being the same as the students in terms of being in conflict, while the reflection and specific advice through feedback and INSET were clearly important aspects of the change process.

## Teacher B

- *Experimentation*

Thirty-one responses were interpreted as being associated with experimentation and were subsequently categorised into the same two themes as Teacher A. Firstly in terms of use of the approach and progression, he commented on using the teacher's guide as a rigid framework (E:1), where he taught the pillars in order (E:5). He stated that the initial lessons didn't go well for this reason (E:12) and that he hadn't needed to be so rigid (E:9). In terms of adapting the lessons, he noted this consistently throughout all three interviews (E:2,3,6,14,17,18,21,29). In the first interview he commented that he was now more critical of the lesson plans in terms of thinking how to adapt them (E:2,3,6) whereas before he didn't deviate from them (E:3). By the third interview, he noted that he needed to be happy with the practical aspects of the lessons (E:25), which therefore allowed him time for the other cognitive activities (E:26). He stated that he didn't really use the students' SRT data in the first interview (E:7,8), but stated he was using the data for grouping by the second interview (E:19). He did note a time pressure in terms of planning (E:24), but stated it was about the same as other lessons (E:4), and that he used previous notes when planning (E:30). Secondly with respect to specific references to the methodology, he consistently referred to handing it over to the students (E:10,11,13,15,20,22,28,31) and to challenging the students in other lessons (E:14,16,23). In the last interview, he noted the progress he had made on this level:

*"So at the beginning of the year I suppose with a lot of people I was just trying to give them the answer. I was leading them too much..., you know it's getting them to do the thinking and the talking and the discussion and all you're doing is just prompting them*

*occasionally ..., so I think that's one of the things is just keeping my mouth shut and letting them do the talking."* (E:28)

He was also clear about the flexibility (E:27) needed by the teacher when the onus of the lesson in terms of cognitive activities is on students' responses and comments.

- *Collaboration*

The nine responses that related to collaboration were categorised into the same broad area as Teacher A. The area that was emphasised the most was how it had helped with the practical side of CASE (C:1,2,3), in particular the earlier INSET sessions which looked at specific lessons (C:5); he recommended that it would be good to look at the more difficult lessons in the future (C:6). He had found listening to others useful (C:4) as it had allowed him to think practically (C:1), to hear what other teachers had found difficult (C:7) and to decide whether or not he agreed with their comments (C:1). In terms of the importance of collegiality, he stated that everyone learns from feedback (C:9), but that the feedback in each session had got progressively longer, taking up nearly the whole time in the last session (C:8).

- *Lesson observations and feedback*

As there were only three responses that related to lesson observation and feedback, they were combined into one general area. Of the one direct question regarding the usefulness of the observation schedule, like Teacher A he did not refer to the time spent on cognitive activities but focused on the strengths and recommendations which he commented were fine and in line with his own reflections (O:2). This led to a follow-up question about a

possible improvement to the process in terms of getting observed teachers to write down their own reflections to use as a basis for feedback; he thought this would be a good idea as it was often the standard way to ask teachers how they thought the lesson had gone (O:3). There was only one other reference which was in the first interview when he recalled the specific advice I had given to him, regarding reducing his affirmation of students' responses (O:1); I instead encouraged him to ask other students if they agreed/disagreed and why (appendix 3b(ii) - LO2(R):d).

- *Modelling*

The twelve responses that related to modelling were categorised into the same two themes as Teacher A. Firstly with respect to seeing the methodology, he noted that my demonstration lesson had allowed him to see the adaptation of a lesson, the different aspects of the lesson as well as how I interacted with the students (M:1,11). He stated that: "*As long as I can see how to do it at the ABC then I'm usually ok* (M:8)." Secondly in relation to the usefulness, he gave a strong indication that it was extremely important to watch good practitioners (M:2,3,4), emphasising the need for the teacher to hand it over to the students. He stated that he learns from observing how others do it (M:6,7,12) and then trying it for himself (M:5). He commented that he would have liked more observation (M:10), but his answers did not indicate any preference for the demonstration lesson compared with the video clips shown during INSET sessions (M:6,7,9,10,12). On the whole his references to modelling were generalised rather than specific to the demonstration lesson, only referring to it twice other than when directly asked about it.

- *Process of Change (PoC)*

Of the nineteen parts of the three interview transcripts that were analysed in relation to the PoC, they were categorised into three themes with the first two being the same as Teacher A's. In terms of the process of learning, eight related to him watching lessons and/or videos (PoC:2,4,5,11,12,15,16,17) on the methodology and two to discussion with colleagues (PoC: 13,18); he did not once, however, explicitly refer to learning through reflection including not using the journal (PoC:7). He mentioned that everyone struggles with handing the discussion over to students (PoC:3) and that he had been influenced by other intervention approaches (PoC:14). The strong emphasis on learning through watching and then trying it himself was mentioned in every interview where he stated that: *"I'll watch somebody do something and then I'll go and try it myself and then I'll learn from my mistakes or, you know, and that's how I'll learn (PoC:11)."* With respect to how he learned by observing others, he stated that it allowed him to adapt lessons (PoC:2,10), to be critical (PoC:1), to apply methodology to other lessons and approaches (PoC:6,8,14) and to know how much the lesson involved (PoC:9). Lastly, in the third interview he made an interesting comment about how he had changed not just in his own confidence, but in his confidence of the students in terms of handing it over to them (PoC:19).

In summary, the responses of Teacher B during the three interviews indicated that the most important mediating factor for him in terms of the PoC was modelling through observing good practitioners and watching video clips. His emphasis on experimentation would indicate that this was also important, but he did state that it would have taken him

longer to progress on his own compared with being able to watch effective practitioners (PoC:5). Collaboration through the INSET sessions was seen as useful, but there was generally an emphasis on the practical side in relation to discussing specific lessons. When asked specifically about the importance of collegiality, he responded positively, but his initial response was about observing others as opposed to the discussion part of the INSET sessions. His answers indicated that the mediating factor which was the least important was lesson observation with feedback mainly because he only referred to it once other than when asked about it specifically.

### **Teacher C**

- Experimentation

Twenty-six responses were interpreted as being associated with experimentation and were subsequently categorised into the same two themes as Teachers A and B. Firstly in terms of progression, a lot of her comments were retrospective which may be why they were often in the third person. In relation to her own progression, she stated in the second and third interview that she had improved in her questioning of students, which she related to having fewer time constraints with the class because she only taught them CASE (E:19,24,25) as well as to watching video clips and discussing questions during INSET (E:18). In addition, she commented that teachers needed a supportive environment to try things out (E:20). She noted that she was able to adapt lessons because of her understanding (E:2,17,21) especially reducing data collection (E:4,8), as well as knowing where the equipment is a problem (E:10,16). She mentioned that initially it took a lot of time to plan lessons (E:1), where she would consider how she:



*“might inadvertently ‘give the game away’ during discussions (E:3).”* She noted that her planning time had been reduced especially because of her familiarity with the equipment (E:5) and that her intuition had been developed by doing the activities so many times (E:26). She did note that time was a constraint rather than her knowing what to do (E:11,13). She noted in the third person that teachers who are new to CASE use it like a recipe (E:9,14) partly because there are so many things going on (E:15). Unlike Teachers A and B, she had used the students’ SRT data for grouping students (E:7) at the beginning of the year. In terms of the methodology with respect to role of the teacher and students, she mentioned that CASE allows all students to speak compared with normal lessons (E:6), the focus on students’ conflict (E:12,23) and that knowing students helps in class discussion (E:22).

- *Collaboration*

The nine responses that related to collaboration were categorised into the same broad area as Teachers A and B. In terms of the usefulness, Teacher C mentioned that it had been helpful in terms of pace of lessons and questioning (C:1,5), including watching the video clips. She noted that it had been good to recap the pedagogy in relation to specific lessons (C:2,4) and was positive about the timing of the INSET sessions in terms of one every half term (C:3). She stated the INSET sessions were one of the positives of the year in terms of working with other colleagues (C:7,9), where a supportive environment is needed (C:6), but noted an issue with teachers being at different level of PD with CASE (C:8).

- *Lesson observations and feedback*

There was only one response that related to lesson observation and feedback which was in response to a direct question in the third interview about the usefulness of the structure of the observation schedule. Teacher C discussed the timing part with respect to timing of pillars, noting that she could understand it, but didn't think it was suitable for novices (O:1). She did not mention the part relating to strengths and recommendations and when asked a follow-up question of whether she had found this aspect useful, she responded yes but did not expand on her answer.

- *Modelling*

The three responses that related to modelling were categorised into the same single area. Teacher C mentioned finding the videos clips useful for questioning (M:1) and only mentioned my demonstration lesson once when asked directly about its usefulness. She stated that it was interesting to see how I managed group work (M:2), especially with unfamiliar students (M:3).

- *Process of Change (PoC)*

There were only three comments that related to the PoC in relation to the themes identified for Teachers A and B. The lack of evidence was mainly due to Teacher C being an experienced teacher who reported that her knowledge and understanding, as well as confidence and views on learning, had not been altered. She noted that she had used the research journal once after her first observation to write down the order in which things had happened (PoC:1). Therefore it related to preparation for the feedback meeting with

no mention of reflection. She did comment that she recognised the value of the journal but struggled to find the time (PoC:2). In terms of the process of learning, she mentioned the usefulness of INSET in terms of: *“just being able to reflect back and having discussions again that I have had previously about the pillars and how they relate to some of the specific lessons, specific activities (PoC:3).”*

In summary, based on the evidence of Teacher C’s responses it would be difficult to interpret which mediating factor was the most important in the PoC, mainly because she reported that she had not changed but had had an opportunity to recap. The number of comments, however, relating to experimentation could possibly show how she had developed and changed through teaching the activities for the last seven years without specific input other than attending a year of INSET sessions<sup>54</sup> and CA convention.

### **Comparison of Teachers**

For Teacher A, lesson observation with feedback was the most important mediating factor whereas for Teacher B, it was hardly referred to and Teacher C only once when directly asked about it. For Teacher B, observing other teachers and watching video clips was the most important as this related to his process of learning through watching and then experimenting. Teacher A mentioned the demonstration lesson throughout all three interviews; her responses related to her learning through observing as it caused her conflict, but at the same time it allowed her to see the methodology in its entirety. In terms of collaboration and working with others, there was parity for all three teachers in

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<sup>54</sup> This was the network I ran during 2001-2002 involving six schools. Teacher C was an NQT, working at a different school before joining the RBT school.

terms of the usefulness of hearing others' views especially about specific lessons, but all three raised issues, including teachers being at different levels (Teacher C), feedback taking up too much time (Teacher B) and a preference for a one-to-one approach (Teacher A). Experimentation through teaching CASE and planning was clearly important for teachers to consider their progress especially in terms of changing from a mechanical use to a more fluid adaptable approach. In summary, for Teachers A and B there were clear differences in how they reported learning which in part related to the importance they gave to particular mediating factors. Teacher C's responses did not give enough evidence to base a judgement on, partly because she answered some of the interviews in the third person and partly because she was already experienced with the CASE methodology.

## ***Part II: Students' Science Reasoning (SRT) scores – pre and post***

### **One year of CASE lessons: September 2007- September 2008**

The SRT results of Task II - Volume and Heaviness - for each student were processed by converting the overall test score to a Piagetian score. As discussed in Section III, SRT scores can be converted to an interval scale which has Piagetian stage equivalents; (Wylam & Shayer, 1978, 2001). The data was sent to Denise Ginsburg, at Science Reasoning<sup>55</sup>, for an analysis of the results, including a comparison between the pre-test data at the start of Year 7, September 2007, and the first post-test data, September 2008, at the beginning of Year 8. The full reports of the respective pre- and post- tests can be found in appendix 5a and 5b respectively, albeit with the omission of students' names.

The main findings of the comparative data are as follows:

- **Table 6** A comparison of the results of the pre- and post - SRT scores for Task II - *Volume and Heaviness* - in terms of mean Piagetian level and mean percentile ranking for the cohort of 149 matched students

	<b>Pre-test: Sept 07</b>	<b>Post-test: Sept 08</b>	<b>Difference</b>
<b>Mean Piagetian level</b>	4.75	5.14	0.39
<b>Mean percentile</b>	63.8	69.5	5.7

The mean Piagetian levels of the cohort for both the pre-test, September 2007, and post-test, September 2008, were determined, using students' individual Piagetian scores; the analysis was based on one hundred and forty nine students who took both the pre- and

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<sup>55</sup> Science Reasoning produces reports on the SRTs for schools; this has annually been the practice for the school which participated in this research. Denise Ginsburg processed all three SRTs which have been included in this section and some of her commentary has been drawn upon. In addition, personal correspondence between Denise and me has been included when additional clarification was deemed necessary.

post- tests. These scores were used to determine the mean percentile rank<sup>56</sup> of the cohort which gave an indication of progress. A summary of this comparative data is shown in Table 6. The difference in mean Piagetian percentile ranking of 5.7 was an increase in the cohort's ranking for the one hundred and forty-nine matched students; the report (appendix 5b) states that this was not, however, a significant increase, and therefore could not be attributed to above expected progress. An increase of 0.5 standard deviations, at a probability level of 0.05, would have been the minimum expected change for the results to be seen as significant; this would have equated to a mean Piagetian level of 5.57, which is higher than the result of 5.14 for the post-test.

- **Table 7** A comparison of the results of the pre- and post- SRT score for Task II - *Volume and Heaviness* - in terms of the mean Piagetian ranking for each class

<b>Class</b>	<b>Mean Percentile Pre-test: Sept 07</b>	<b>Mean Percentile Post-test: Sept 08</b>	<b>Difference</b>	<b>Effect size</b>
<b>7C*</b>	52.0	64.5	12.4	0.32
<b>7G*</b>	88.6	88.0	- 0.7	-0.04
<b>7H</b>	49.8	66.8	17.0	0.41
<b>7R*</b>	59.9	53.7	- 6.2	-0.17
<b>7T*</b>	65.9	66.9	1.0	0.03
<b>7Y</b>	56.1	71.0	14.9	0.36

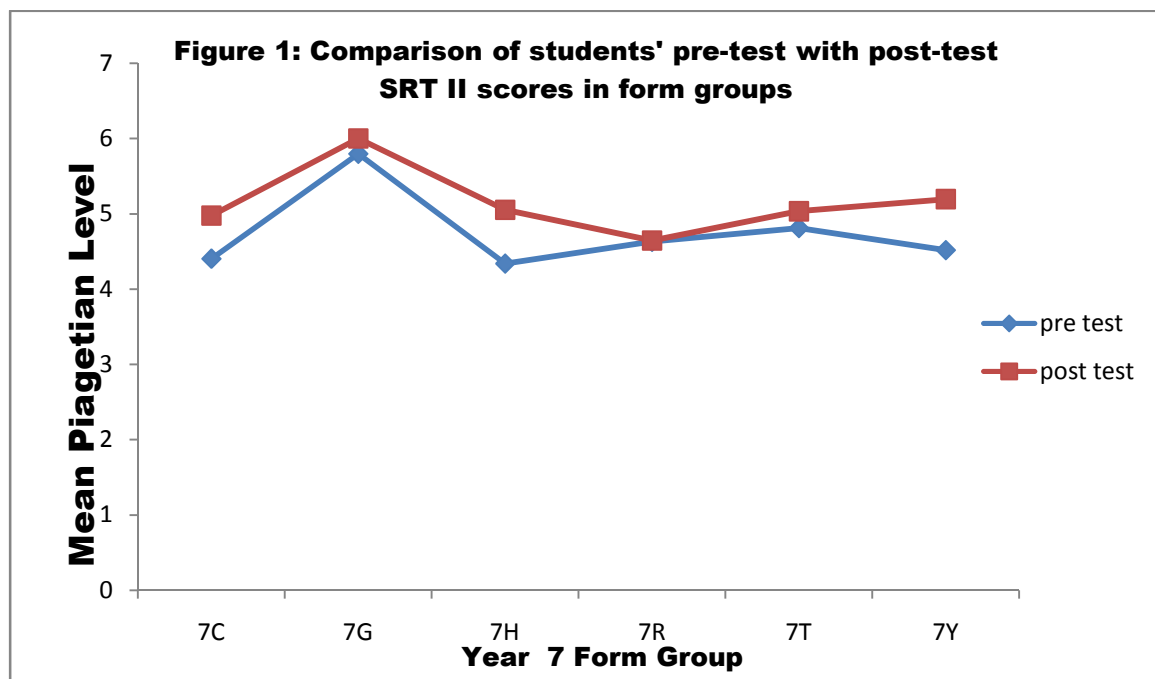
\* Classes taught by a participant teacher

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<sup>56</sup> The CSMS norms, which have been expanded upon in Section III, have been re-standardised (Shayer, Ginsburg & Coe, 2007) to give new norms compared to original 1976 data. For the purpose of the RBT, Ginsburg used the re-standardised norms to determine the cohort's mean percentile rank.

Table 7 and Figure 1 show the mean Piagetian percentile rank for each of the six classes in September 2007 compared with September 2008 which allowed for comparisons to be made between the respective progress of each class (Shayer, Ginsburg & Coe, 2007).

The effect sizes, when comparing the means of the pre- and post- tests for each group, were not significant for any class, where an effect of 0.5 of a standard deviation is usually required (Ginsburg, 2010). Figure 1 shows graphically the results for each form, which illustrates that there are several interesting factors worth consideration.



- The spread of mean percentile ranking at pre-test

The class with the highest ranking in both the pre- and post- test is the language class which is made up of mainly band one students (top 25%) based on the school and LA's Year 6 tests. The percentile difference between the highest -7G- and lowest -7H- is nearly 40. The other five classes are meant to be of a similar mix in ability and this data

indicates that this is not the case as there is a considerable difference in the mean percentile ranking between 7T and 7H of 16.1.

- The classes with the highest and lowest effect sizes

There is a pattern between the mean pre- test percentile ranking and effect size; the three classes with the lowest mean percentile pre- test score showed the largest effect sizes and vice versa: 7H had the lowest mean percentile rank for the pre-test of 49.8 and the largest effect size of 0.41; 7G had the highest mean percentile rank for the pre-test of 88.6 and the second lowest effect size of -0.04. This reflects a ceiling effect and therefore this class should have taken either SRT III or IV, which would have allowed them to answer questions of a higher cognitive level.

- Classes that were taught by participant teachers

The four classes with the lowest effect sizes were all taught by participant teachers; this means that 7H and 7Y who had the largest effect sizes of 0.41 and 0.36 respectively were taught by teachers who did attend the CASE INSET sessions run by me, but did not participate in the other parts of the research such as lesson observations and coaching. Interestingly, the two classes with the lowest effects sizes, 7G and 7R, were both taught CASE by the same participant teacher. 7C had the third highest effect size of 0.32; this participant teacher taught this class only on a fortnightly basis and did not teach the class for the rest of their Science curriculum.



### Two years of CASE lessons: September 2007- September 2009

In September 2009, the students, who were at the start of Year 9, all took the Equilibrium in Balance SRT Task IV; this is the recommended time and test to post-test students as they have completed the CASE programme of lessons and enough time has passed to measure cognitive gains. The analysis was based on the one hundred and forty three matched students between the pre-test, September 2007, and post-test, September 2009. The students' Piagetian scores were sent off again to Science Reasoning for further analysis; the full report can be found in appendix 5c. It is important to note that some of the comparative data used is different to the previous set because this comparison is between two different tests – SRT II, Volume and Heaviness, and SRT IV, Equilibrium in Balance. In addition, whilst the pre-test data used the 2003 re-standardised norms, the post-test used the established 1980 norm; this has an impact upon the judgements that can be made, which will be expanded upon in the conclusion.

- **Table 8** A comparison of the results of the pre- and post - SRT scores for Task II – Volume and Heaviness – with Task IV – Equilibrium in Balance - in terms of mean Piagetian percentile ranking for the cohort of 143 matched students (93% coverage)

	Pre-test: Sept 07	Post-test: Sept 09	Difference
Mean Piagetian level	4.74	6.29	1.55
Mean percentile	63.8	60.7	-3.1

Table 8 shows that whilst the mean Piagetian level increased from 4.74 to 6.29, the mean percentile rank of the cohort decreased slightly by 3.1 percentile ranks. The mean Piagetian level would have needed to be at least 6.85 before it could be inferred that the intervention had had an effect (Ginsburg, 2010). Figure 2 shows the difference for each form group between their mean pre-test and post-test Piagetian level; this shows that there was an increase for all classes in line with the whole cohort.

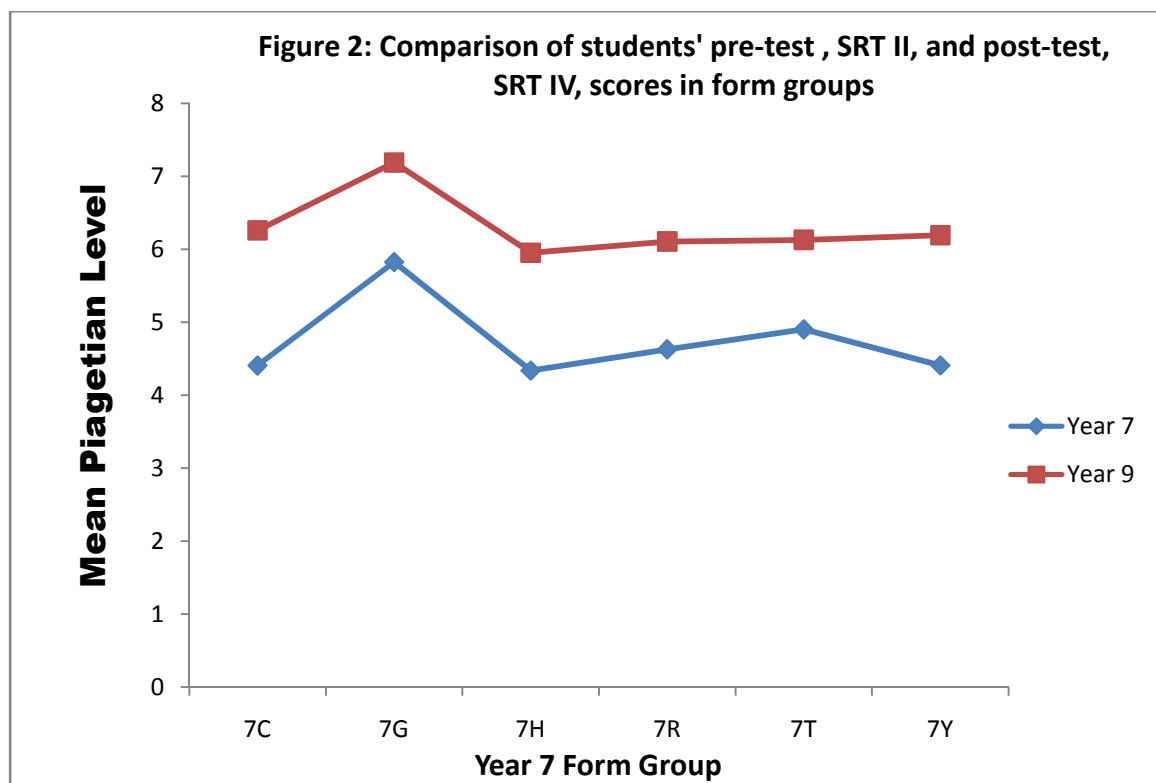


Table 9 shows a comparison of the standard deviations from the mean for SRT II and the estimated mean for SRT IV; the difference in standard deviations gives an indication of whether any form group made significant progress.

- **Table 9** A comparison of the results of the pre- and post - SRT scores for Task II – Volume and Heaviness – with Task IV – Equilibrium in Balance - in standard deviations (SDs) from the respective means of both tests

<b>Class</b>	<b>SDs above task II Sept 07</b>	<b>SDs above task IV's estimated means Sept 09</b>	<b>Increase in SDs</b>
<b>7C*</b>	0.07	0.28	0.21
<b>7G*</b>	1.36	1.29	-0.07
<b>7H</b>	0.01	-0.05	-0.06
<b>7R*</b>	0.27	0.12	-0.16
<b>7T*</b>	0.52	0.14	-0.38
<b>7Y</b>	0.07	0.21	0.14

The report states (appendix 5c) that there were no significant cognitive gains for any class. The highest increase in standard deviation was 0.21 with four out of the six classes showing a decrease. The ranking order showed again an interesting pattern, having the same divide as the previous post- test analysis (SRT II: September, 2008); the three classes with the lowest percentile rank from the pre- test had the most positive change and vice versa. This would not have been in part due to a ceiling effect for 7G, unlike the previous post-test, because SRT IV tests the highest cognitive level.

**Table 10** The percentage of pupils with formal operational thinking compared with the national average for both the pre-test, SRT II Volume and Heaviness, and post-test, SRT IV Equilibrium in Balance

Task	Pre-test SRT II: Sept 07	Post-test SRT IV: Sept 09
National Average	3.36	No data available
School	4.2	15.5

Table 10 shows that there is an increase in the percentage of students with formal operational thinking. In the post-test report (appendix 5c) it noted that the increase is *probably* significant; this was later checked and then changed to *probably as expected* (Shayer, 2010). The reason for this level of uncertainty with respect to the data is based on the re-standardisation of the SRTs (Shayer, Ginsburg & Coe, 2007, Shayer & Ginsburg, 2009), which is expanded upon in the conclusion. This is also why there is no data for the national average.

## Section V: Conclusions

The conclusion section is separated into four parts. Part I considers the main findings of the results section on teachers' PD in relation to existing literature; in addition, it highlights some of the implications of the findings in terms of the PD of teachers with CASE, which are expanded upon in the last part as recommendations. Part II focuses on the interpretation of the student outcomes as measured through SRT data, including the issue of recent changes to the benchmark norms. Part III evaluates the findings of the RBT both in terms of methods of collection and interpretation of both teacher and student data. Finally, Part IV develops the main points raised from Part I, focusing on the implications of the RBT's findings as well as future recommendations.

### ***Part I: Findings of teachers' PD in relation to existing literature***

This part considers the two research questions by relating the findings of each construct to existing literature on teachers' PD.

**Question 1** *How does a teacher change in terms of his/her classroom skills, attitudes/beliefs and knowledge/understanding of the theoretical underpinnings of CASE as he/she develops an ownership of the methodology and how can the nature of the change process be characterised?*

### **Knowledge and understanding**

In terms of how the teachers' knowledge and understanding changed, there was a clear separation for all three teachers between the psychological models and the CASE methodology. Feuerstein et al (1980), in relation to the training of teachers with IE,

outline four knowledge bases which they state must be mastered for teachers to implement the scheme successfully. The first relates to the underlying theory and the other three to practical applications and therefore the same distinction is evident. Cochran-Smith and Lytle (1999) highlight issues surrounding the traditional dualism of formal knowledge and practical knowledge, including the lower status often given to the latter, partly because it is seen to relate more to teachers' knowledge. In considering Shulman's (1986) knowledge bases such as pedagogical knowledge and pedagogical content knowledge (PCK), these seem to relate to both the psychological models and CASE methodology as they include how students cognitively develop as well as the strategies used by teachers in the classroom to deal with misconceptions.

Eraut's (1994) emphasis on the reciprocal relationship between theory and practice may be more useful for considering this separation. His description of practical knowledge has already been aligned with teacher ownership where knowledge is interpreted rather than replicated and is not valid for a teacher until he/she has practised and adapted it. Therefore in relating Eraut's practical knowledge to the findings of the RBT, teachers reported that their understanding of the methodology increased partly through delivering CASE lessons. Teacher A and C's accounts, however, would not support a reciprocal relationship in terms of the psychological models and the methodology. Teacher A did not report that the former had changed throughout the course of the year, whereas Teacher C stated that teachers need the understanding of the former to allow them to adapt the approach in the classroom. On the other hand, Teacher B did not mention anything relating to the psychological models throughout all three interviews other than

his emphasis on the practical side of CASE. In applying Teacher B to Mevarech's model (1995), it states that a conceptual change, at level four, is related to changes in pedagogical understanding; therefore Teacher B may need to focus on this in the future for his teaching skills to develop beyond a competent practitioner.

Leat's (1999) separation of craft knowledge and PCK is the most aligned with the findings of the RBT, where teachers' craft knowledge is related to their classroom practice and is '*turned upside down* (p 394)' when they embark on an innovation like CASE; this relates to the use of the novice-expert literature where expertise is related to specific contexts such as CASE that require a different formation of craft knowledge compared with curriculum lessons. Leat's position supports a stage model in terms of the development of teachers' craft knowledge. In terms of PCK, Leat relates CASE to teachers' knowledge and understanding of the reasoning patterns, mentioning the psychological models, but with very little detail about the specifics. The RBT's analytical framework considered teachers' knowledge and understanding of the CASE methodology in terms of how it related to the use of the CASE pillars and reasoning patterns in the classroom as well as the roles of the teacher and students. The reason why teachers' knowledge of the reasoning patterns was not directly questioned was because there was an assumption that teachers could understand scientific concepts in these terms. In her last interview when asked about planning and delivering CASE lessons, Teacher A was the only teacher to mention her understanding of the concept in relation to a reasoning pattern: "*I would need to a) get my head around the reasoning pattern, if I didn't understand it give myself more than a couple of days just to work out, you know, if I*

*needed to ask a maths teacher or if I needed to work out what it was (K&U:12).*” Leat suggests it is unlikely that teachers have conceptualised scientific concepts in terms of reasoning patterns. This position was supported by the second INSET session when I asked the teachers to reflect upon the scientific concepts they had taught that day in terms of the reasoning patterns; Teacher A commented upon this as a useful part of the INSET session during her first interview (K&U:3), including teachers being active in the session; I noted in my journal, however, that all teachers had found this activity difficult, which would support Leat’s conjecture.

In summary, the findings of the RBT have highlighted the complexity of considering knowledge in relation to the CASE project from three teachers’ perspectives, especially with respect to theory and practice. Eraut’s (1994) distinction is the most aligned with the teachers’ self-reported data in relation to the development of their respective practical understanding of the CASE methodology as well as Leat’s (1999) description of the development of craft knowledge. In considering the evidence in terms of the differences between researchers’ and practitioners’ knowledge bases, Hiebert et al (2002) state that researchers often try to make distinctions whereas practitioners try to make connections; they expand positing that practitioners’ knowledge is linked to practice, is detailed, concrete and specific and is integrated. Glaser (1996) supports this position, positing that in the development of expertise, knowledge becomes more connected. These descriptions resonate with the participant teachers especially the way they alluded to a connection between theory and practice and therefore may be worth considering in the future.



## **Attitudes and Beliefs**

In relation to attitudes and beliefs, confidence with the methodology was mentioned by all three teachers which could be seen as related to the negative and positive aspects of Mevarech's model. In their first interview, Teachers A and B reported to emotions such as feeling uncomfortable, struggling and being in conflict; these could be seen as relating to the negative parts of the 'survival' stage of Mevarech's model. One of the reasons for including attitudinal data, which the EPPI centre (Cordingley et al., 2007) reported was low for studies that looked at student outcomes as well as teacher outcomes, was because barriers to the change process, conflict or interference, had been posited by Mevarech to be part of the learning process through constructivism for teachers. In addition, through obtaining data through interviews, generally using open questions, teachers were able to elaborate on their personal experiences rather than having to complete an attitudinal questionnaire (Fang, 1996). Therefore as both teachers reported in the third interview that they had developed a confidence with the CASE methodology over the course of the year, this could be aligned with their developing a sense of ownership through a process of change that involves being in, and resolving, conflict in relation to classroom skills. In addition, Teacher C's comments about confidence to adapt the lessons would also be aligned with Mevarech's model in relation to the adaptation stage. Therefore confidence with the methodology is a construct that teachers reported changing through their PD experience and could be seen as supporting teachers' learning through constructivism as they need to feel a lack of confidence, discomfort, in order to reconstruct their knowledge and skills.

In relation to views on learning, whilst Teachers B and C stated that their views had not changed, both having been first introduced to CASE during their PGCE at King's College, London, Teacher A did report a change, which she explained related partly to seeing how students responded to conflict. This could also relate to her response at the beginning of the year on the initial questionnaire where to the statement: '*Year 7 pupils are generally capable of reflecting about their own thinking*', she ticked the 'disagree' box, whereas the Teacher B and C ticked the 'agree' boxes (appendix 7b)<sup>57</sup>. Teacher A's position would support Guskey's (1986) conjecture that teachers change their attitude and beliefs once they have experienced changes in their students.

Finally, the RBT did not separate attitude and beliefs into different types. Harland and Kinder's (1997) model of PD outcomes, which was expanded upon in the background literature, separated attitude and beliefs into three different areas: motivation and attitudinal, which relates to self-concept, affective, which relates to confidence and a sense of competence, and finally a value congruence between the teachers and the aims of the PD. In applying these to the findings of the RBT, the questions in the semi-structured interviews did not elicit responses that related directly to teachers' motivation or their self-concept; Teachers A and B, however, did mention how they felt about the PD process in terms of their learning.

In summary, teachers' confidence with the methodology emerged as a key construct for consideration in future research in relation to teachers' sense of ownership; this could possibly be added to a CASE stage development model, which would help teachers

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<sup>57</sup> This statement relates to the pillar of metacognition.

understand that the process of change involves personal challenges that are expected and not unique to an individual.

### **Classroom practice**

In relation to how teachers developed their classroom skills, the application of a novice to expert stage model showed that the least experienced teachers improved over the course of the year. Berliner (1988) notes that expertise is context specific and that time can vary from two to five years; Glaser (1996) describes the development of expertise as a change in agency over time where experts rely more on self-regulation compared with novices who are dependent on others. Whilst Berliner's model was based on comparisons between teachers, the RBT was longitudinal, through focusing on individual teachers' holistic development based on a continuous stage model as advocated by Mevarech (1995). Desimone (2009) states that research indicates that PD should include twenty hours of contact time, but doesn't specify if that includes using the approach in the classroom. The results of research conducted by Supovitz and Turner's (2000) suggested that it took teachers a long time to change their classroom culture<sup>58</sup> to one of inquiry-based learning, reporting one hundred and sixty hours of PD. These findings, however, were based on teacher questionnaires as opposed to actual lesson observations. In terms of CASE, Adey and Shayer (1994) have advocated a two year PD course. In relation to the mediating factors for change, however, the main input in terms of contact time was INSET and therefore the changes in classroom practice reported in the RBT for Teachers A and B indicate that the process does not necessarily need to be as slow and evolutionary as previously thought.

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<sup>58</sup> Classroom culture related to strategies employed by teachers to promote an investigative environment.

When considering how to develop expertise across any discipline, Ericsson (2008) advocates deliberate practice which helps to overcome: '*arrested development associated with automaticity* (p 991).' If this were to be applied to Teacher C, her practice was judged as proficient in all three observations. Ericsson states that individuals have actively to seek goals which relate to higher standards of performance in order to develop expertise. Therefore in applying this to the findings of the RBT, teachers could be given explicit guidance about their performance in relation to a stage development model; this could be one of the ways for the project to overcome automaticity which Teacher C's observations would support and could be beneficial for both trainers and teachers. In addition, it would help to formulate the future goals for all teachers, irrespective of their level, where PD would be focused on deliberate practice.

In summary, the stage development models -novice to expert- were useful and applicable to elicit the changes that occurred in teachers' classroom practice. The time it takes for significant change, especially as evidenced by Teacher A, did not appear to follow the posited slow process (Adey, 2004); this could be explained through the explicit nature of the learning process brought about by specific mediating factors which would support Ericsson's (2008) advocacy of deliberate practice.

## **Question 2**

*How important to the process of change are the mediating factors of experimentation, collaboration, lesson observation with feedback and modelling?*

## **Experimentation**

Experimentation is clearly an important mediating factor of teacher change. The CASE project encourages teachers to adapt the activities as part of the process of developing a sense of ownership of the methodology. It was clear from all three teachers that the teacher's guide was initially followed like a recipe; this relates to the descriptions of the initial phase of stage development models in terms of Berliner's (1988) development of expertise in pedagogy, Joyce and Showers' (2002) levels of transfer and Mevarech's (1995) U-curved model. In the context of CASE, the initial mechanical use of the teacher's guide was also reported by Leat (1999) and Jones and Gott (1998) and therefore it raises the question regarding the term experimentation with respect to how appropriate it is for teachers new to CASE. For example, in Clarke and Hollingsworth's (2002) model, enactment is the term they use for a teacher experimenting with a new idea rather than simply acting it out. All three teachers were clear in their comments that there are lots of different aspects to CASE lessons in relation to its methodology; therefore in the initial phases of development, should the recommendation be for teachers to simply follow the lesson plan to help build up the episodic knowledge (Berliner, 1988) and confidence to allow for experimentation? Both Teachers A and C emphasised the need to be able to deal with the practical and technical aspects of the lesson which allowed Teacher C to adapt activities and Teacher A to focus on the cognitive activities. Therefore an important consideration is whether or not teachers who are new to CASE should be encouraged to adapt lessons in the initial phase of development.

## **Lesson observation and feedback**

With respect to lesson observation and feedback, Teacher A's comments would support Joyce and Showers' (2002) position that coaching is an essential part of PD in relation to levels of transfer. For Teacher B, however, it was hardly referred to even though several aspects of his progress related to specific recommendations that were based on previous observations (appendix 3b). Interestingly, Berliner's (1986, 1988) position regarding mentors is that it may be better to have competent or proficient practitioners working with novices because they are: '*analytical enough to communicate their reasons for thinking and acting the way they do* (p24).' This could partly relate to Joyce and Showers' (2002) move to peer coaching and is worth considering especially in relation to the longevity of CASE when there is a short supply of CASE tutors<sup>59</sup>.

## **Modelling**

In terms of modelling, whilst this clearly was the most important mediating factor for change for Teacher B, the responses by Teacher A raise the question about the timing of the one demonstration lesson at the start of the year. The one-year Let's Think! PD programme (Hewitt & Hewitt, 2004) included six school visits over the course of the year, where the first term focused on teacher-tutor demonstrations and the second term on observation and feedback. Teachers reported modelling their questioning skills on the teacher-tutor and that centre-based simulations and school-based demonstrations were some of the most useful parts of the programme. Whilst they did not report any issues in terms of the placement of the demonstration lessons, Teacher A's experience of trying to

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<sup>59</sup> The CASE tutor list can be found on the CA website, which lists only a few CASE tutors : [http://www.cognitiveacceleration.co.uk/courses/come\\_tutors.html](http://www.cognitiveacceleration.co.uk/courses/come_tutors.html)

replicate an experienced practitioner where there were too many things to focus on may be worth further consideration. For example, modelling the methodology could begin with short video clips to show different aspects of the lesson in relation to the pillars and then demonstration lessons could be used once teachers had moved on from the novice stage of replication of the teacher's guide.

### **Collaboration**

In terms of collaboration, there was a degree of ambiguity about the importance of this mediating factor. Whilst all three acknowledged the usefulness of listening to others' ideas, for Teacher A it did not fit in with her one-to-one approach and her need for expert guidance; this could be because it was not compatible with her process of learning and therefore was the reason why she did not see it as very important compared with lesson observation and feedback as well as modelling. On the other hand, Teacher B responded more favourably; this could be because it was more compatible with his mode of learning as video clips were shown in most sessions and specific activities were discussed. For the two teachers with the least experience with CASE, the evidence would suggest that collaboration is not an essential part of the learning experience in relation to collegiality compared with other factors. Therefore whilst the second EPPI centre review (Cordingley et al., 2005a) found that studies that were individually-focused in terms of CPD compared with those that were collaboratively- oriented reported comparatively weaker gains and were fewer in number, Timperley (2008) stated that numerous studies had found weak relationships between participation in collaboration and student outcomes.

In the context of the RBT, whilst collaboration with colleagues may have been useful in terms of sharing experiences and having a collective vision (Bolam et al., 2005), the way it impacted on teachers' learning was questionable. In the future, possibly more consideration needs to be given to roles of more experienced teachers in departments that have teachers with a range of experience and expertise; this was raised in the second interview regarding the longevity of the scheme and the use of INSET sessions, eliciting a range of responses:- Teacher A maintained the importance of modelling, observation and feedback (D:7), Teacher B suggested focusing on the practical side and possibly pairing teachers (D:1) and Teacher C also raised practical concerns as she stated that the equipment often holds teachers back (D:1).

In summary, the importance of each mediating factor showed clear variation between the two most inexperienced teachers. By relating the findings to existing literature, it has helped to elucidate important areas for future consideration in relation to teachers' PD with the CASE methodology such as when novice teachers should begin to adapt lessons and whether competent practitioners are in a better position to coach novices compared with experts.

### **Process of change**

One of the primary focuses of the RBT was to explore the process of change that teachers undergo as they develop an ownership of CASE methodology. In relation to how teachers learn, Teacher A's description would support Adey and Shayer's (1994) position that the PD is constructivism for teachers; this supports Borko and Putman's (1995) conjecture



that the learning experience for students and teachers should be the same, which relates to Teacher A's comment about feeling uncomfortable: "*we have to be able to do that to even somewhat understand what it's like for them* (PoC:5)." Teacher B also mentioned struggling with the lessons, but his description of how he learned was consistently being able to watch experienced practitioners and then trying it out for himself, whereas Teacher A focused on lesson observation and feedback. Therefore the self-reported evidence would indicate that the two teachers, who both had had little formal PD with CASE, learned through a process of constructivism, but that the emphasis was on different mediating factors to bring about change. Teacher C is not included because there was very little evidence of how she had learnt retrospectively. Of interest, however, was that she had not had any lesson observation or feedback before participating in the research. The main PD inputs had been the CASE network and CASE conventions and over the six years of teaching CASE she had developed into a proficient teacher; therefore her positive responses regarding INSET sessions may have related to her previous experiences of learning about CASE. In relation to models of PD, the findings would support the view of approaches that consider it as a cyclical process (Guskey,2000, Clarke & Hollingsworth,2002) where there are multiple opportunities for learning (Timperley, 2008), but that teachers are made more aware of the process of development. In addition, the approach used for teachers' PD should not necessarily be a uniform experience for teachers.

In summary, the findings of the RBT support PD literature on constructivism (Borko & Putman, 1995) where the process of change involved active processes for the teachers in terms of their learning.

### **Additional Findings**

The main findings of the RBT support previous research, which have found that individuals respond differently to PD (Harland & Kinder, 1997, Simon et al, 2006) and therefore the process of change needs to be considered on an individual basis. Whilst there were similarities such as teachers' improved confidence with the methodology and initial struggles in the classroom, the emphasis on different mediating factors for Teachers A and B would indicate that PD programmes need to have a flexible approach to different PD inputs, but at the same time be more explicit about the developmental process. Therefore a continuous stage development model would need to be clear about the expected progression of knowledge and understanding and classroom skills, but also be flexible about the process of change through allowing multiple opportunities for teachers to learn. Berliner (2001) considers individual differences in relation to the relative roles of talent versus deliberate practice in terms of the development of expertise, where the latter is seen as more important. Based on research across different fields, the powerful effect of deliberate practice is repeatedly found as a necessity for development of expertise irrespective of individual differences (Ericsson, 1996). A cautionary note about models is summarised by Grundy and Robinson (2004) when looking at recent trends in teachers' CPD in Australia: *'Stage theory of professional development tends to constitute the teacher as passive in the development process. It is always something else*

*that triggers growth and receptivity to change and is induced by a set of life circumstances rather than through individual predilection (p157).'* In a CASE development model, the emphasis on deliberate practice would overcome the idea of teachers being passive participants. In addition, Berliner (1988) acknowledges that any developmental theory should not dictate that certain experiences should be avoided at different levels, but that consideration should be given to where they are best placed. This relates to the findings of the RBT in terms of when teachers should be encouraged to experiment and adapt as well as the placement of any demonstration lessons.

Finally, in the context of the development of expertise, Dall'Alba and Sandberg (2006) state that one of the main limitations of stage models is that they mask the actual skill being developed. Whilst they acknowledge that Dreyfus and Dreyfus (1986) extended previous models in terms of skill development being context-dependent and needing practical experience for development, it still lacked clarity about the nature of the skill being developed. A consideration of the skills being developed would be extremely useful for any model of teachers' PD with CASE as it would make explicit the techniques being used in the classroom by the teacher as he/she facilitated the cognitive activities.

### **Overall summary**

The main aim of the RBT was to explore the process of change that teachers undergo as they develop a sense of ownership of the CASE methodology. The first question addressed how teachers changed in terms of their knowledge and understanding, attitudes and beliefs, and classroom practice. The main findings were that teachers recognised a

difference between the knowledge of the psychological models and that of the CASE methodology, placing differing values of importance on each knowledge base. Stage development models (Mevarech, 1995) would suggest that a teacher will not develop beyond the competent stage without engagement with the former. Confidence was clearly an important construct which developed for the two least experienced teachers over the course of the year and was a clear indicator of them developing a sense of ownership with the methodology. The change in teachers' classroom practice, through the use of a stage development model from novice to expert, helped to show the importance of the need for episodic knowledge to allow teachers to begin to adapt lessons and become more deliberate in their practice. Development in classroom practice was evidenced by teachers becoming more fluid use of the methodology and intuitive in their responses to students' comments.

One of the main findings of the second question, which focused on the actual process of change, emphasised that individual differences in teachers' preferred learning experiences was an important consideration. For the two inexperienced teachers, whilst their self-reported data would suggest the learning experience was constructivist in nature, involving active processes, the importance they placed on different mediating factors highlighted the need for multiple and differing opportunities to learn and develop. In addition, the time it took Teacher A to develop into a proficient teacher would indicate that the process does not need to be described as such a slow, evolutionary process, but can be accelerated through focused, deliberate practice. Finally, consideration of the mediating factors in relation to existing literature has highlighted salient questions about

how best to support the change the process which will be addressed in the last part on future recommendations.

The findings of both research questions would support the relevance and usefulness of a stage development model that combines how teachers are likely to change – knowledge and understanding, attitudes and beliefs, and classroom practice – and the process of change through a constructivist approach where development is through a range of mediating factors that promote ‘active’ learning.

## ***Part II: Students' Cognitive Development***

In terms of student outcomes, for the first post-test analysis, SRT II (September 2008), the change in mean Piagetian level from 4.75 to 5.14 did not indicate that the CASE intervention had resulted in a statistically significant cognitive increase for the cohort beyond expectation. When the students were post-tested with SRT IV in September 2009 when they had completed the intervention, the results were in line with the findings after one year where the increase in mean Piagetian level again did not indicate that the CASE intervention was associated with gains beyond expectation.

In considering the results of the individual classes after the first post-test where the three classes with the lowest percentile ranks made the most progress and vice versa, Ginsburg (2010) states that the differential results could be due to a range of factors with curriculum effects being the most likely - for example, brighter classes not being stretched. 7G, the class with the highest mean Piagetian level, however, should have taken a different SRT test with higher cognitive levels. In the discussion section of the report (appendix 5b), it emphasised that students need exposure to challenging concepts to help maintain and develop formal operational thinking. In relation to the Year 9 post-test, whilst the ranking order had changed in terms of amount of progress (using the difference in the standard deviations from each respective test's mean, Table 9), there was still the same divide with respect to the top three and bottom three classes and 7G's results could not be related to a ceiling effect. The students had had another year of exposure to CASE lessons and their whole curriculum, but the same pattern remained with respect to the amount of progress made. To conclude, both post-tests showed that the students had not made significant gains in their cognitive development by being

involved in the CASE scheme. The additional analysis of classes did, however, raise questions about the gains made by students in terms of their pre-test level.

Overall, these results raised various questions about the effectiveness of the scheme at the school as well as how challenging the school curriculum was in terms of developing of students' cognition. There was, however, a major issue about the analysis of the SRTs based on the re-standardisation of the SRT II norms. The Year 7 results place the school at 63.9 mean percentile rank using the 2003 norms; when using, however, the 1976 norms as these were higher, the school was at the 40.4 mean percentile rank (appendix 5a). In terms of the Year 9 post-test, as already mentioned, the old 1980s norms were used; this was because the new norms do not follow a normal distribution and the gender means have hardly changed (Shayer & Ginsburg, 2007). Therefore if the old norm for the pre-test, SRT II, was used instead, the cohort of matched students would have increased from a 40.4 to a 61.5 mean percentile rank; as a change of fifteen percentile ranked scores is equated with significant cognitive gains (Ginsburg, 2011), the cohort could have been judged as making significant gains. This would mean that as in previous years, the school was able to deliver effectively the CASE scheme, which resulted in significant cognitive gains for the cohort of students. Therefore as the school used to get significant gains based on the old norms, consideration needs to be given to the use of the SRTs due to the level uncertainty regarding the norms; this is expanded upon in the next section.

### ***Part III: Evaluation of the RBT***

This evaluation part is separated into a review of my multiple roles, the two methods for data collection -the lesson observations and semi-structured interviews-, additional areas of consideration and the SRT data.

#### **Evaluation of Multiple Roles**

In relating my role within the school to the research, Teacher A mentioned it had affected her (D:5,6,8). When asked in the third interview about my Deputy Headteacher role, she stated that it had impacted on the first observation, but that she coped better for the second one. It was therefore fortunate for the purposes of the research that she felt that she was able to move on from this position once she felt the inputs, especially feedback, were improving her delivery of CASE lessons. It does, however, raise the issue of the demand characteristics that she experienced because of my senior role within the school; this needs to be an important consideration for any researcher carrying out a study within his/her own institution and the RBT takes the position that it would have been better to carry out the research in a different school which had already established CASE, but had teachers new to the scheme.

In terms of balancing my different roles as a trainer to all the CASE teachers in the department, a coach to the three participant teachers as well as a novice qualitative researcher, it definitely affected the research in numerous ways. Firstly, the dual purpose of the lesson observation as a PD input, as well as a measurement of classroom practice, meant it was very difficult to focus in lessons on both aspects and therefore the commentary given to teachers had to be used for both purposes. Secondly, in INSET



sessions there were a lot of important comments made by participant teachers as well as feedback on the sessions provided by all teachers (appendix 8b) which were not used as it was not possible to lead the training session and be a researcher at the same time. Finally, I struggled to balance my full-time responsibilities at school as well as carrying out the research. In the summer term, I wrote the whole school timetable for the first time; this meant it was very difficult to balance the research with my workload which had exponentially increased. Whilst this could not have been foreseen in terms of the time and focus the timetable took, it would have been better to have completed the research during an academic year when I did not have a significant new responsibility.

### **Evaluation of Lesson Observation**

In terms of data collection, it would have helped if I had used an audio recording machine, focusing on the teacher's approach as opposed to student discussion. This would have improved the descriptive validity (Maxwell, 2002) of the data, where I could have used specific dialogue to feedback to teachers as well as evidence for the judgements I made about the teacher's classroom skills. In addition, it would have helped if another CA researcher was available to allow for inter-rater reliability (Denzin & Lincoln, 1994) where we could have compared our respective judgements of the lesson. Finally, the structure of the observation template, whilst it allowed for a systematic approach, meant that I had to focus on the timings of the pillars, which were only crudely completed as I tried to concentrate at the same time on specific feedback. This could have been improved by either an audio recording of the lesson and/or an additional researcher. In addition, its usefulness for PD and research purposes in its current format is

questionable, especially as each lesson is different in terms of the pillars and therefore it could be developed to relate to a developmental model; this is discussed in the last part of this section. On a positive level, all three teachers agreed that its format was useful in terms of strengths and recommendations.

### **Evaluation of Semi-structured Interviews**

There was an inconsistency in my approach as the interviewer. I asked the interviewees only at the end of the first interview whether they had anything else they would like to mention if they hadn't already had an opportunity to do so. As mentioned in Section III, I did not conduct the second and third set of interviews at the lower school as intended. These interviews were conducted in my office and in most of the interviews there were disturbances, including the telephone ringing. My inexperience as a researcher was evident in terms of talking too much during Teacher A's first interview (D: 1-4) as well as an inconsistent use of asking follow-up and probing questions. For example, during the last interview I spent too much time with Teacher B on his responses to his initial questionnaire compared with Teachers A and C. In addition, there were specific responses of Teacher C in her final interview where I did not ask her to expand upon her answer, accepting her short affirmative response (D: 2, 3).

As outlined in the methods, the majority of questions were based on the constructs relating to the analytical framework through both direct and indirect questions. There were several questions used at the beginning of the second interview that did not elicit responses from Teachers B and C that were useful for answering the research questions.

The overall approach meant that the evidence obtained on the different constructs was influenced by the balance between the direct and indirect approach. An improvement would have been to ensure that this was structured better from the beginning and possibly to have piloted the questions with a non-participant teacher. In terms of positives, being the sole researcher, trainer and coach, meant that I knew what they were referring to, which helped with my interpretations of the transcripts (Arksey & Knight, 1999).

### **Additional Considerations**

The decision to select teachers with a range of backgrounds with CA was partly based on taking into account teachers' existing repertoire of skills and knowledge (Joyce & Showers, 2002). Whilst Teacher C was able to discuss certain aspects of her development retrospectively, she did not serve as a particularly useful subject in order to answer the research questions. The two main reasons were because she did not change very much in her classroom practice and she often answered questions in the third person, which made it difficult to interpret whether her responses related to herself and/or to others. There was a permanent Science teacher who had a similar background to Teacher B and on reflection he would probably have served as a better participant teacher in relation to obtaining evidence to answer to the research questions. He attended all the INSET sessions and provided feedback to all but one (appendix 8b), which reflected his enthusiasm for CASE.

In the recommendations to all three teachers after observations, I consistently noted questions to help facilitate the pillar of metacognition, including focusing on it during

INSET sessions. The findings of the research would indicate that more consideration needs to be given to how teachers can get students to think about their thinking.

In terms of the use of the journal, whilst it was encouraged as a PD input, only Teacher A used it throughout the year. In addition, I struggled to use mine consistently, especially during the summer term. As already mentioned the use of journals in research has reported similar findings (Hewitt & Hewitt, 2004, Simon & Johnson, 2008) and therefore an alternative approach may be worth exploring as part of a more explicit PD developmental model.

Finally, all three teachers were told to focus on my questioning technique during their respective demonstration lesson and/or encouraged to use the systematic template in terms of timing of the pillars. All three teachers ignored the latter and our discussion afterwards generally focused on the teacher's role as a facilitator. It was clearly far too much to have expected as even I struggled to use it and therefore a different structure should be considered, including a different focus depending on a teacher's level of development.

### **Evaluation of SRTs**

In all three tests, the reports (appendix 5a, 5b, 5c) contain a commentary on the test administration. The main tool used was question analysis where the numbers of students who answered the question correctly for each class were compared with an established

reference line<sup>60</sup>. For the Year 7 pre-test, whilst the class profiles showed a consistent pattern to the reference line, some issues were identified which indicated possible over-marking of questions 12 and 13b (two of the three questions that measure formal operational thinking); for the two post-tests, there was a good correspondence of the class results for each question with the reference line. A check of the students' tests for the pre-test did uncover that there was some over-marking and therefore, Ginsburg calculated this could have caused a slight decrease in mean Piagetian percentile rank of the pre-test using 2003 norms from 63.9 to 61.9. Therefore if this is applied to the 1976 norms, the cohort would have been around two percentile ranks below 40.4; this would indicate that the change in mean percentile rank between the Year 7 pre-test and Year 9 post-test was even larger and therefore adds substance to the position that significant gains were made in terms of students' cognitive development.

In response to my query concerning the probable gains noted in the report on the Year 9 post-test due to the percentage of students who were measured as formal operational thinkers (appendix 5c), Shayer (2010)<sup>61</sup> stated that: *'The problem is that, these days, there are too many sources of uncertainty. Our two papers on the drop in levels since 1976 on both VH in Y7 and EB/Pend in Y8/9 showed that on both we had, in effect, an elastic ruler.'* Therefore with respect to the established norms of the SRTs, the level of uncertainty associated with them has made it difficult to base any judgements or draw inferences. As mentioned in the conclusion, this suggests that until a new system of

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<sup>60</sup> See Figure 1 in appendix 5b and 5c and Figure 4 in appendix 5a.

<sup>61</sup> This is a personal correspondence in response to my query about the comment in the report, appendix 5c, which stated that the percentage of students with formal operational thinking was probably a significant increase.

testing is devised or stable norms are established, the SRTs cannot be used to determine whether a cohort has made significant gains compared with normative data.

#### ***Part IV: Implications of RBT, including Future Recommendations***

One of the main recommendations of the RBT would be to devise a stage developmental model of the CASE PD programme, which would be a version of the Joyce and Showers' (2002), which was context specific, and would use Berliner's stages as a template in terms of a beginning teacher moving from novice to expert. It would also incorporate aspects of Mevarech's U-curve model as this is more holistic, including changes in knowledge and attitudes such as confidence in adapting the methodology. It would be a continuous development model rather than discrete changes and could work in parallel with a newly devised lesson observation schedule. The model would help to establish a standardised approach among CASE trainers/tutors especially in relation to developing teachers' classroom practice. Cordingley (2008) states that: '*Professional learning, like student learning, needs to be personalised within their professional context, either by the learners themselves or by partnerships of learners, CPD facilitators, researchers and school leaders* (p 49).' The main findings of the RBT are reflected in this comment; teachers are different in the way they construct knowledge and change in their classroom practice, especially in terms of the usefulness of different mediating factors. Therefore as mentioned in the conclusion, individual differences would need to be considered in a CA stage development model, including the placement of different mediating factors.

An application of the model would be that it would allow teachers to have a more tangible measurement of their progress which was requested by Teacher A (PoC:16,17,18); in addition, it would help to make the PD processes explicit to trainers and teachers, which the EPPI centre (Cordingley et al., 2007) has reported was lacking in

CPD literature. The emphasis would be on deliberate practice (Ericsson, 2008) so that all teachers, irrespective of their level of development, would be able to monitor their learning and set achievable goals. This would relate to the self-regulation that Timperley (2008) and Glaser (1996) advocate for effective PD in relation to how teachers learn.

In terms of the CASE specialists, consideration would need to be given to the level of expertise and training required to train and coach other teachers. As already mentioned, Berliner (1988) posited that it may be better for a competent practitioner to work with a novice compared with an expert. Using competent/proficient practitioners to work with novices would promote them into deliberate action, which Ericsson (2008) posits helps them to overcome automaticity in order to reach professional expertise. Whilst all three participant teachers emphasised the importance of the role of the specialist, Teacher C stated that she preferred trainers who had gone through the same experience, which relates to this model, whilst Teacher A was consistent throughout all three interviews in suggesting that expert guidance was needed. Berliner's suggestion, however, is definitely worth exploring within an explicit PD development model, especially due to the shortage of CASE tutors.

In relation to the recommended time period, the findings of the RBT indicate that it could be reduced with the strategic use of specific mediating factors, including consideration of individual preferences. The CASE INSET programme could also consider allowing competent/proficient practitioners to lead parts of the INSET programmes as part of their development. In relation to types of knowledge, Wilson and Berne (1999) suggest that



models need to be constructed to measure teachers' acquired knowledge, including attending to the differences already highlighted between professional and teacher knowledge. The knowledge base should be part of the developmental model, including some consideration of types of knowledge. As beginner teachers progress, consideration needs to be given as to when they should be encouraged to adapt lessons; the evidence of the RBT indicates it should be after the novice stage. The use of modelling, especially a full lesson demonstration by an expert, could be used for teachers at a competent stage, or teachers should be encouraged to observe teachers who are one or two levels higher in terms of the PD with CASE. With respect to SRTs, it is important that a new tool is established or schools could consider using another test such as the MidYIS (Middle Years Information System) test (Tymms, 2004), which shows a good correlation with SRT II, to measure the cognitive progress within a school if normative data is not possible.

In summary, an explicit model of teachers' PD with CASE, allowing teachers and trainers to consider explicitly the learning process, could help with the longevity of the scheme, in part by increasing the number of individuals involved in the PD of other practitioners. It would allow all CASE teachers, irrespective of their level, to set goals for the future. Attention would need to be given to individual differences, the role of coaches, the placement of demonstration lessons and the type of knowledge bases. Whilst this may on one level seem to be a divergence from Adey and Shayer's (1994) position of allowing teachers to take ownership of the methodology, it would actually be trying to structure and make explicit the overall process. One of the overarching aims would be to

allow teachers to regulate their learning which can be seen as aligned with developing a sense of ownership. The work, in developing the model and PD programme, could be done in conjunction with other CA projects, especially as a new professional association of CA tutors is being established where the PD of teachers is a key consideration, including access to membership.

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# Appendices

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## **Appendix 1**

## **Literature**

1a

Intervention Approaches

1b

Stage Development Models

## **Appendix 2**

## **Analytical Framework**

## **Appendix 3**

## **Teacher Observation Schedules**

3a

Teacher A – three observations

3b

Teacher B – three observations

3c

Teacher C – three observations

## **Appendix 4**

## **Semi-structured interviews**

4a

Teacher A – one transcript

4b

Teacher B – one transcript

4c

Teacher C – one transcript

4d

Question Schedules – I, II & III

4e

Themes of constructs

4f

Distribution of constructs

## **Appendix 5**

## **Science Reasoning Reports**

5a

Pre-test report

5b

Post-test I report

5c

Post test II report

5d

Précis of changes to SRT norms

## **Appendices**

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5e	SRT II - Volume & Heaviness
5f	SRT IV – Equilibrium in the Balance
<b>Appendix 6</b>	<b>Summary of PD Inputs</b>
<b>Appendix 7</b>	<b>Teacher Questionnaire</b>
7a	Questionnaire
7b	Summary of responses
<b>Appendix 8</b>	<b>INSET</b>
8a	INSET handouts
8b	INSET feedback
8c	INSET summary questionnaire
<b>Appendix 9</b>	<b>Journal Guidance</b>
<b>Appendix 10</b>	<b>Calendar</b>
<b>Appendix 11</b>	<b>List of Acronyms</b>

## **Appendix 1a: Intervention Approaches**

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Since the 1970s there has been a plenitude of published short term research into intervention-type programmes that focus on students' cognitive ability (Adey & Shayer, 1994). Some could be categorised as panaceas for students' inability to cope with the content matter of a particular course; this is stated in the literature review as one of the reasons for the need for a programme such as CASE in terms of the gap between the conceptual difficulty of the National Science Curriculum and students' levels of cognition. McGuiness (1999), in her review of approaches for developing pupils' thinking, separated the interventions into three categories - those that aim to develop general thinking skills; those that develop thinking in specific subject areas and those that adopt a cross-curricular approach. Whilst these categories allow certain programmes to be considered in more than one category, they are still helpful when considering the theoretical differences of each programme in terms of cognition.

### **General Approaches**

These programmes generally build upon a Piagetian theoretical viewpoint especially about the generalist stance that any cognitive gains will be transferable because of the development of the brain in terms of a central processor (McGuiness, 1999).

The well known intervention work of Reuven Feuerstein in Jerusalem in the 1950s (Feuerstein, 1980) focused on an educational achievement issue with a sociological background in that those immigrants from a Middle Eastern background did less well in school compared to those from a European and Northern American background. His team ended up focusing on the development of adolescents over a two year period or longer. The intensive programme they set up – Instrumental Enrichment (IE) - focused on generic cognitive processes and was content free. The psychological model that underpins this programme has many similarities to CASE through advocating Vygotsky's social mediation model for cognitive development and the Piagetian model of mental operations, where the classroom becomes a Mediated Learning Environment (MLE). There have been numerous

## Appendix 1a: Intervention Approaches

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replications of IE, including Blagg (1991), where no significant gains were found for students when measuring student outcomes. Having conducted a critical review of IE research including the mixed results of the original research, Shayer & Beasley (1987) undertook a small scale piece of research with twenty students in a special school which involved them being withdrawn for three hours of IE a week for twenty months. The publication of the results included a comparison with the original IE programme and a North American replication<sup>1</sup>. The study reported effect sizes in the order of one standard deviation on cognitive measures that had not been previously reported. As with the original study effect sizes for achievement measures were modest. Whilst it is noted that changes in students' achievement in curriculum based tests could only be an indirect consequence of IE it recognised that: *'unless the effects of IE appear in school achievement and in work/life skills its use could still not be justified* (p 115).' A clear difference between Blagg (1991) and Shayer & Beasley's (1988) respective research is the number of teachers and students involved, with significant results being found in the small-scale study. It highlights the issues that arise when the size of a study/project increases in terms of the number of confounding factors. Another example of a context- free heuristics based programme was de Bono's CoRT (Cognitive Research Trust) (1976). Of particular interest in this scheme was that the approach advocated in the teachers' notes was instructional rather than interventional in terms of the different heuristics for thinking. This meant that the teacher would make explicit to the students the heuristic that was the focus of the lesson and acronyms were used so that students could easily recall which one was being focused on or used in a different situation e.g. CAF –*Considering All Factors in the situation: exploring a situation before closing on a possible solution.*

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<sup>1</sup> The original study was referenced as Feuerstein et al., 1979 with the North American study as Haywood et al., 1982.

## Appendix 1a: Intervention Approaches

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Other approaches which have certainly added to the richness and diversity of intervention approaches that try to develop students' general thinking ability include the Somerset Thinking Skills (STS) course (Blagg, Ballinger & Gardner, 1988); this uses the principles of IE, but in school-based contexts. The STS approach has kept training teachers as a central focus, offering residential weekends and has also branched into occupational settings. Also there is the Philosophy for Children (P4C) programme, developed by Michael Lipman (1980) in the US, which focuses on student dialogue, questioning and rationality, through a metacognitive approach where students 'think about thinking'. There were evaluations of P4C published by Lipman in the early 1980s which gave empirical support for the value of this programme in terms of students' performance on specific tests (McGuinness, 1999). A more recent study<sup>2</sup>, using a more contemporary set of materials based on the P4C programme, engaged primary school students aged ten in one hour a week of intervention for sixteen months (Topping and Trickey, 2007a). The results showed consistent significant gains across all experimental schools with the control schools showing no gains in any aspect. The researchers concluded that their results supported the incremental view of intelligence (Dweck & Leggett, 1988) which would support Adey and Shayer's model of a general processor, whilst contradicting theories of intelligence that suggest multiple intelligences (Gardner, 1993). The researchers did a follow- up study two years later looking at the long term effects using the same post-test measures (Topping and Trickey, 2007b). Again significant differences were found showing the original gains for participant students had been sustained with higher achieving students showing the greatest gains. The issues of scaling up and sustainability are issues which have been raised by McGuinness (1999). Topping and Trickey (2007b) carried out a search using two search engines and found that of

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<sup>2</sup> The quasi -experimental approach allowed eight experimental schools within a Scottish local authority to be compared to control schools within the same authority. The measure used to see if the intervention caused cognitive gains for the participant students was the updated version of the Cognitive Abilities Test (CAT) (Smith et al., 2001).

## **Appendix 1a: Intervention Approaches**

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nearly five thousand studies that referred to thinking skills in a classroom context only seventeen reported sustainable gains.

The intervention approaches, of which CASE, CAME (Adhami, Johnson & Shayer, 1998) and CATE (Hamaker, Jordan, & Blackwell, 1997) (Cognitive Acceleration through Mathematics and Technology Education respectively) are all examples, focus on intervening in the development of students' cognitive development through using a specific curriculum context. The theoretical underpinnings of these programmes are explicit and the cognitive gains of some of the participant students showed sustainability and raised attainment in English, Mathematics and Science GCSEs (Adey and Shayer, 1994). The reasoning patterns are not subject -specific and, therefore, any subject could develop them as the subject is just the platform or vehicle used to develop these general reasoning patterns.

### **Subject specific approaches**

The clear difference between this category and the first one is that the programmes set out to develop specific skills in a particular subject area or domain by identifying the skills that are seen as specific to the subject. The main subjects identified in McGuiness' review (1999) were Mathematics, Science, History and Geography. Some of the examples of different subjects are listed below:

- In Mathematics research - how to develop problem-solving (Schoenfeld, 1982)
- In Science – how to develop inquiry (Linn et al., 1996) and how to develop scientific reasoning (Halpern, 1992)
- In History - how to develop historical interpretations by comparing the skills of professional historians and students (Wineburg, 1991)

## Appendix 1a: Intervention Approaches

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- In Geography - a curriculum development project subject called *Thinking through Geography* (Leat, 1998)<sup>3</sup> which identifies the concepts that are important for the learning in Geography.

Whilst the above mentioned projects and/or research may differ in the type of programme, intervention and empirical evidence, they are clearly different in their subject-specific focus to the programmes in the first sub-section that are trying to develop general thinking ability through either a given context or no context.

Mehl (1985) was an example of a study that doesn't quite fit the general or subject category as it had a curriculum focus in terms of attainment but had a clear pedagogical focus on cognitive deficiencies. Working at the University of the Western Cape in South Africa, Mehl investigated his students in terms of the nature and locus of different cognitive impairments to address the issue of the high percentage drop out of students from medical school in the first year because they failed his Physics course. Mehl developed a new style course for an experimental group. This course focused on the cognitive deficiencies of students, identified through student interviews, rather than solely on the content; this new style course led to a dramatic decrease in the failure rate from nearly fifty percent to zero for the experimental group compared to the control group. This research, along with a replication of this study at a London comprehensive school (Strang & Shayer, 1993),<sup>4</sup> shows clear similarities with CASE in terms of a focus on students' cognitive abilities. It could be argued, however, that any programme that tries to 'cure' a particular achievement issue will end up focusing on the context at hand and will inevitably start to instruct students towards the strategies needed to achieve in that context. One of the major emphases of the in-service CASE training is explaining to teachers why CASE lessons were not designed to be taught in conjunction with

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<sup>3</sup> Leat (1999) review titled "Rolling the Stone Uphill" has been drawn upon in the literature review as a pertinent article on intervention approaches, including CASE.

<sup>4</sup> J Strang replicated Mehl's study with a below average Year 9 class in terms of using the same student interview method of identifying, and then focusing on students' cognitive deficiencies, in a six week introductory course. The effect size for the experimental class was 1.15σ.



## **Appendix 1a: Intervention Approaches**

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the Science curriculum. This is one of the fundamental changes that teachers need to understand about cognitive development programmes, such as CASE, in that it requires a long- term holistic view of a child's development rather than a short- term achievement view. This stance was certainly not supported by Jones and Gott (1998) when they suggested a connection should be made between the early CASE lessons and the procedural knowledge required for the investigation work of the then National Curriculum.

### **Across the curriculum – Infusion approaches**

McGuiness (1999) proposed a third category where general thinking skills are developed across the whole curriculum. McGuiness cited the Activating Children's Thinking Skills (ACTS) (McGuiness et al., 1997) project which built upon the work of the American SPELT project (Strategies Program for Effective Learning /Thinking) by trying to promote the development of thinking skills of primary school students at Key Stage 2. Seventeen teachers attended six training days and were encouraged to develop their own lessons. The project resulted in a handbook being published with examples of lessons that can be taught across nine subjects of the Northern Ireland curriculum. Dewey & Bento (2009) recently published the findings of an investigation of the infusion methodology to activate students' thinking skills because of the lack of evaluative evidence, regarding the effectiveness of the scheme on students' cognitive development. A quasi-experimental design was used which involved pre- and post- testing students' cognitive abilities as well as self-perceptions and social skills. The results showed that the experimental group made significant cognitive gains compared to the control group<sup>5</sup> but mixed results were reported regarding other factors that were linked to attitudinal factors. In terms of teachers' professional development this was done through whole or small group training and reflection led by the researchers. It did not involve any

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<sup>5</sup> The control group were titled the *waiting list control group* because the researchers had decided that ethically students should not be denied the intervention and therefore it was delayed for these students. Cognitive skills were measured using the CAT 3 test – Cognitive Abilities Test.

## **Appendix 1a: Intervention Approaches**

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observations or one-to-one coaching and teacher outcomes were measured through staff questionnaires which were completed at the end of each year of the two year projects. Positive outcomes were found for all aspects which included the ACTS intervention, teacher development and pupil development. This is another example of research that focuses solely on teacher outcomes with no elaboration of CPD processes. It did not consider the nature of the change process for teachers; for example, teachers' knowledge and beliefs were not considered before they started the PD. Overall the PD programme of workshops being led by researchers very much links to the description by Fraser et al (2007) of CPD through a transmission model of learning for the teachers.

In summary, through putting theory into practice, a purely interventionist approach allows students to construct new meaning themselves through the mediation and facilitation of the teacher in collaboration with their peers. In all these approaches it builds students' capabilities in the learning and developmental processes rather than dependency (Hamaker, 1996). For such schemes to succeed it is essential that teachers gain an understanding of how students can develop through intervention approaches and how they can facilitate and control such experiences.

### **References**

References are given below if they are not part of the main bibliography. As some are taken directly from Adey & Shayer(1994) or McGuiness's reviews of intervention approaches, the references are therefore separated into the following three parts:

1. References not cited in main thesis where original source has been used
2. References only cited in Adey & Shayer (1994)
3. References only cited in McGuiness (1999)

## Appendix 1a: Intervention Approaches

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### 1. References not cited in main thesis where original source has been used

Dewey, J., & Bento, J. (2009). Activating children's thinking skills (ACTS): The effects of an infusion approach to teaching thinking in primary schools. *British Journal of Educational Psychology*, Vol. 79: 329-351.

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Lipman, M., Sharp, M., & Oscanyan, F. (1980). *Philosophy in the Classroom* (2nd ed.). Philadelphia: Temple University Press.

Topping, K. & Trickley, S. (2007a). Collaborative philosophical enquiry for school children: Cognitive effects at 10-12 years. *British Journal of Educational Psychology*, Vol. 77(2): 271-278.

Topping, K. & Trickley, S. (2007b). Collaborative philosophical enquiry for school children: Cognitive gains at 2 year follow-up. *British Journal of Educational Psychology*, Vol. 77(4): 787-796.

### 2. References only cited in Adey & Shayer (1994)

de Bono, E. (1976). *Teaching Thinking*. London: Maurice Temple Smith.

Mehl, M. (1985). The cognitive difficulties of first year physics students at the University of the Western Cape and various compensatory programmes. PHD thesis, University of Cape Town.

Strang, J., & Shayer, M. (1993). Enhancing high school students' achievements in chemistry through a thinking skills approach. *International Journal of Science Education*, Vol. 15(3): 319-337.

### 3. References only cited in McGuiness (1999)

Halpern, D. F. (1992). *Enhancing thinking skills in the science and mathematics*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Linn, M. C., Songer, N. B., & Eylon, B. S. (1996). Shifts and convergence in science learning and instruction. In Berliner, D. C., & Calfee, R. C. (Eds.), *Handbook of Educational Psychology*. New York: Macmillan.

Leat, D. (1998). *Thinking through Geography*. Cambridge: Chris Kington Publishing.

## **Appendix 1a: Intervention Approaches**

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McGuinness, C., Curry, C., Greer, B., Daly, P., & Salters, M. (1997). Final Report on ACTS project: Phase 2. Submitted to Northern Ireland Council for Curriculum, Examination and Assessment.

Schoenfeld, A. H. (1982). Measures of problem-solving performance and of problem-solving instruction. *Journal for Research in Mathematics Education*, Vol. 13: 31-49.

Wineburg, S. S. (1991). Historical problem solving: A study of the cognitive processes used in the evaluation of documentary and pictorial evidence. *Journal of Educational Psychology*, Vol. 83: 73-87.

## Appendix 1b: Stage development models

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Berliner's model was based on different research that was outlined and discussed in Berliner (1986 & 1988) where the focus was on the expertise of pedagogy. The research to support this model was comparative not longitudinal (Berliner (1988) acknowledged that the latter was needed), through comparing expert, novice and postulant (individuals from industry with subject expertise but had never taught) teachers. The development of expertise model was based on Dreyfus and Dreyfus' (1986) five stage generic model of expertise.

Joyce and Showers' (2002) model was used to rate teachers' implementation of alternative teaching models as part of a district-wide school improvement program (Richmond County, Georgia), which aimed to increase student achievement. The eighteen sample teachers were observed and interviewed six times over the course of the year after participating in a summer workshop, where instruction was based on the theory/demonstration/practice model. The teachers then met again in study teams once the teaching had started. The levels of transfer schedule was used as the analytical tool; it contained mainly context-related description at each level, which has been omitted and therefore only the generic information from the model has been used.

Mevarech's (1995) U-curve model is a stage development model which differs from Dreyfus and Dreyfus' (1986) model through considering the negative aspects of an initial decline in a teacher's performance. The main body of evidence for the model was based on two pieces of staff development projects: one focused on cooperative learning environments (Mevarech et al., 1991) and the other related to the implementation of mastery cooperative-learning in heterogeneous classrooms (Mevarech & Susak, 1993). The two projects were selected because expert teachers had to start to use computers and/or cooperative mastery learning to develop their teaching; in addition, there were technical and non-technical aspects to teachers' development and the different projects allowed for a broader generalisation.

## Appendix 1b: Stage development models

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### References only cited in this appendix

Mevarech, Z. R., Silber, O., & Fein, D. (1991). Learning with computers in small groups: Cognitive effects and Outcomes. *Journal of Educational Computing Research*, Vol. 7: 233-243.

Mevarech, Z. R., & Susak, Z. (1993). Effects of learning and cooperation- mastery method on elementary students. *Journal of Educational Research*. Vol. 86: 197-205.

### Analytical Framework I

#### Processes

**Process of change:** *how teachers learned and developed, including cognitive processes that related to the constructivist theory of learning and development as well as how the change process could be characterised.*

**Mediating factors:** *any factor used in the research that brought about changes in participant teachers' knowledge/understanding, classroom practice, and attitudes towards the CASE pedagogy and methodology, including coaching, experimentation, demonstration lessons, reflection and collaboration.*

#### Outcomes

**Knowledge and understanding of CASE methodology and pedagogy:** *specific references to the CASE pedagogy in terms of theoretical underpinnings, including Piaget and Vygotsky, as well the methodology in relation to the CASE pillars, reasoning patterns and role of teacher.*

**Classroom practice:** *a 1 to 5 (5 high) grading system based on analytical models of Berliner (1988) and Joyce & Showers (2002);*

**Attitude and beliefs:** *any reference to an opinion and/or a positive or negative viewpoint such as confidence, motivation and difficulties*

#### Overall

In Adey's (2004) book on the PD of teachers, the construct -sense of ownership- permeates the book, being drawn upon in all the cited CA empirical research. This emphasises the multi-faceted nature of the construct as it is related to individual teachers, groups of teachers and students as well as organisational aspects. It was found that there was a strong correlation between teachers' sense of ownership of the CASE methodology and their: '*concordance with the underlying principles of CASE*' which emphasised the importance of the theoretical

## Appendix 2: Analytical Framework (version1)

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aspects of the innovation. Based on Adey's conceptualisation of the construct, including CA research, as well as Meverech's U shaped model, the construct is coded as:

**Sense of ownership:** *teachers' adoption of the CASE methodology, through an internalisation/conceptual change that allows them to adapt and invent activities; judgements made using 1 to 5 grading system (5 high) from 1 – survival to 5 –invention.*



Date 21/11/07, Teacher A, Observer ML, Class 7G, Lesson 3, No of pupils 24

[illegible]

# Appendix 3a(i): Lesson observation schedule for CASE lessons

Date 21/11/07, Teacher A, Observer ML, Class 7G, Lesson 3, No of pupils 24

Strengths	Recommendations
<ul style="list-style-type: none"><li>• at the start of the lessons the use of the ball – keeping everyone engaged – asking all students ( <b>LO 1(S): a</b>)</li><li>• excellent PowerPoint – very good to recap and ensure concrete preparation of the terms ( <b>LO 1(S): b</b>)</li><li>• good opportunities for construction - allowing students to articulate their reasoning ( <b>LO 1(S): c</b>)</li><li>• excellent planning and preparation and use of space – organisation of the activity went really well ( <b>LO 1(S): d</b>)</li><li>• ability to multi-task especially through demonstration ( <b>LO 1(S): e</b>)</li></ul>	<ul style="list-style-type: none"><li>• Metacognition- when you ask who agrees – why do you agree? common feature post construction – therefore it is beyond the construction and agreement ( <b>LO 1(R): a</b>)</li><li>• less use of your own words to show you agree or disagree – e.g. try not to use excellent – keep putting it back to the class ( <b>LO 1(R): b</b>)</li><li>• not allowing H to dominate – try not to select her, then get her answer and then ask everyone do they agree – otherwise they won't feel confident to disagree ( <b>LO 1(R): c</b>)</li></ul>

Date 2/4/08, Teacher A, Observer ML, Class7G, Lesson 10, No of pupils 24

[illegible]

Strengths	Recommendations
<ul style="list-style-type: none"> <li>• PowerPoint presentation – interactive – students’ names so that all students are made to participate orally in the lessons; also helped the structure and flow of the lesson ( <b>LO 2(S): a</b>)</li> <li>• Good clarification of technical terms – e.g. proportion, variable, correlation( <b>LO 2(S): b</b>)</li> <li>• Use of agree and disagree ( <b>LO 2(S): c</b>)</li> <li>• Organisation – group work – good pace only 10 minutes collecting data ( <b>LO 2(S): d</b>)</li> <li>• Creating cognitive conflict with the original slide( <b>LO 2(S): e</b>)</li> <li>• Recognising that when the discussion dries up that you students should be encouraged to discuss in small groups( <b>LO 2(S): f</b>)</li> <li>• Student engagement in the lesson was maintained throughout the whole double period( <b>LO 2(S): g</b>)</li> <li>• Using ‘interesting’ rather than ‘excellent’ ( <b>LO 2(S): h</b>)</li> <li>• Comparison of the two graphs to help create cognitive conflict ( <b>LO 2(S): i</b>)</li> </ul>	<ul style="list-style-type: none"> <li>• The second relationship statement – allowing H to come up with it rather than let them discuss the relationship ( <b>LO 2(R): a</b>)</li> <li>• Use of reliable /accuracy – possibly was too much for some students and detracted from the activity( <b>LO 2(R): b</b>)</li> <li>• Allow students to use the board when explaining their ideas – e.g. correlation ( <b>LO 2(R): c</b>)</li> <li>• Possibly graph for homework and using the end of the lesson to do bridging work where the groups had to come up with the examples or even why is there this relationship? Can we bridge to other examples? ( <b>LO 2(R): d</b>)</li> <li>• Possibly bringing them all to the front at the end- some were still concentrating on the graph and not the reasoning pattern ( <b>LO 2(R): e</b>)</li> <li>• If the class was not as able may be giving them a template for the graph ( <b>LO 2(R): f</b>)</li> <li>• Check the ICT that is on the CD ( <b>LO 2(R): g</b>)</li> </ul>

### Appendix 3a(iii): Lesson observation schedule for CASE lessons

Date 18/6/08, Teacher A, Observer: ML, Class: 7G, Lesson: 15, No of pupils: 25

[illegible]

# Appendix 3a(iii): Lesson observation schedule for CASE lessons

Date 18/6/08, Teacher A, Observer: ML, Class: 7G, Lesson: 15, No of pupils: 25

Strengths	Recommendations
<ul style="list-style-type: none"> <li>• Excellent ‘hook’ to get the students interested in the topic at the beginning and then the visitor to the party ( <b>LO 3(S): a</b>)</li> <li>• Getting students to use the board or come to the front to try to explain their reasoning ( <b>LO 3(S): b</b>)</li> <li>• Time and preparation of resources and the organisation of the rooms and students ( <b>LO 3(S): c</b>)</li> <li>• Expanding on students’ questions and ideas and not filling the gaps for them – asking another student to explain( <b>LO 3(S): d</b>)</li> <li>• Manner with students ( <b>LO 3(S): e</b>)</li> <li>• Interjecting during group activities when necessary to focus or clarify the task ( <b>LO 3(S): f</b>)</li> <li>• Recognising the need to reduce the time spent on the number –crunching part so that the class could move onto more demanding cognitive activities ( <b>LO 3(S): g</b>)</li> <li>• Handling the discussion to create the conflict for students to be able to resolve the mathematical rule( <b>LO 3(S): h</b>)</li> <li>• Facilitating the final discussion to help the students construct the rule ( <b>LO 3(S): i</b>)</li> <li>• Engagement and enthusiasm was excellent ( <b>LO 3(S): i</b>)</li> </ul>	<ul style="list-style-type: none"> <li>• Language – combinations and permutations ( <b>LO 3(R): a</b>)</li> <li>• Time taken to get them to put ideas up – possibly a little too long for first activity ( <b>LO 3(R): b</b>)</li> <li>• Metacognition – why do you think that is important ? e.g. permutation /combination difference ( <b>LO 3(R): c</b>)</li> </ul>

### Appendix 3b(i): Lesson observation schedule for CASE lessons

Date 10/10/07, Teacher B, Observer ML, Class 7T, Lesson 1, No of pupils 26

[illegible]

## Appendix 3b(i): Lesson observation schedule for CASE lessons

Date 10/10/07, Teacher B, Observer ML, Class 7T, Lesson 1, No of pupils 26

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Strengths	Recommendations
<ul style="list-style-type: none"><li>• Excellent opening and use of visual aids (LO 1(S): a)</li><li>• Good use of moving the discussion on and using students' answers (LO 1(S): b)</li><li>• Excellent use of visual aid (LO 1(S): c)</li><li>• Fantastic example about the relationship between <i>school (named omitted)</i> student and the size of her school bag (LO 1(S): d)</li><li>• Very good discussion techniques – “Can you help me” “I can’t remember” and getting a students to give another one some advice (LO 1(S): e)</li><li>• Willingness to adapt and recap (LO 1(S): f)</li></ul>	<ul style="list-style-type: none"><li>• Social mediation/construction – students should be able at every opportunity to discuss their ideas with their peers (LO 1(R): a)</li><li>• Board – have a scribe – put main words up and with agreed definition (LO 1(R): b)</li><li>• Instruction – need to be careful – you gave the definition rather than giving them a chance to construct the meaning (LO 1(R): c)</li><li>• Consensus – try to get agreement before moving on and create conflict over ideas (LO 1(R): d)</li><li>• Pace – should be able to complete word cards in a double period (LO 1(R): e)</li><li>• Predictions – hide the squares – if I..... can you tell me...(LO 1(R): f)</li><li>• Pillar of metacognition – why do you think that? (LO 1(R): g)</li><li>• Pillar of bridging – can you think of another variable – what are its values? (LO 1(R): h)</li></ul>



### Appendix 3b(ii): Lesson observation schedule for CASE lessons

Date 23/4/08, Teacher B, Observer ML, Class 7T, Lesson 7, No of pupils 24

[illegible]

## Appendix 3b(ii): Lesson observation schedule for CASE lessons

Date 23/4/08, Teacher B, Observer ML, Class 7T, Lesson 7, No of pupils 24

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Strengths	Recommendations
<ul style="list-style-type: none"><li>• Excellent use of visual aids on PowerPoint to support the activity and choice of classification items as it engaged the students (LO 2(S):a)</li><li>• Excellent example in terms of anomalies in terms of vertebrate classification – but possibly the discussion became too science based e.g. the difference between homo/hetero-thermic animals LO 2(S):b)</li><li>• Bring discussions to a close by getting the class to vote – majority – this helped with the insect /human debate but could have been used earlier LO 2(S):c)</li><li>• Manner with the students is very encouraging LO 2(S):d)</li><li>• The CASE approach was evident throughout the lesson; this could have been observed as an example of the CASE methodology LO 2(S):e)</li></ul>	<ul style="list-style-type: none"><li>• Timings –possibly too much time spent on the opening – only 1 &amp; 2 were done on the lesson guide by 3:15pm (LO 2(R):a)</li><li>• Possibly allowing more time to allow students to discuss in groups – they were around the front together for a long time (45 minutes) and most of this was a whole class discussion – “turn to neighbour and quickly discuss..... 1 minute” (LO 2(R):b)</li><li>• Giving a set time for any task – move on when the majority our down – this improved towards the end (LO 2(R):c)</li><li>• Asking other students do they are agree of disagree with another student’s ideas /reasoning e.g. whether to count humans or insects – make it less individually focus and more group focussed; this was done once but no student was asked to explain why (LO 2(R):d)</li><li>• Use the Thinking Science CD- the image would have helped when agreeing numbers (LO 2(R):e)</li><li>• Metacognition – ask students to articulate their thinking why did you think that? How did you come up with that explanation (LO 2(R):f)</li><li>• Try to make sure we hear from all students throughout a double lesson- you did ask people –behaviour issues – rather than the quiet students (LO 2(R):g)</li></ul>

### Appendix 3b(iii): Lesson observation schedule for CASE lessons

Date 23/6/08, Teacher B, Observer ML, Class 7T, Lesson 15 No of pupils: 24

[illegible]

## Appendix 3b(iii): Lesson observation schedule for CASE lessons

Date 23/6/08, Teacher B, Observer ML, Class 7T, Lesson 15 No of pupils: 24

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Strengths	Recommendations
<ul style="list-style-type: none"><li>• Initial introduction – getting the students all around the front and recapping important terms and concepts from previous lessons (LO 3(S): a)</li><li>• Clarity about the set up of the experiment which was necessary (LO 3(S): b)</li><li>• Questioning students throughout the opening plenary and knowing when to move the discussion on (LO 3(S): c)</li><li>• Asking probing questions and asking for evidence/data to back up their answers (LO 3(S): d)</li><li>• Manner with students throughout the lesson was very positive and encouraging (LO 3(S): e)</li><li>• Getting students to write out their own relationship – excellent bridging activity (LO 3(S): f)</li></ul>	<ul style="list-style-type: none"><li>• Having the equipment set up before hand (LO 3(R): a)</li><li>• Time spent on the activity (LO 3(R): b)</li><li>• Interjecting during an activity to move the class on (LO 3(R): c)</li><li>• Increasing the time for the plenary session at the end (LO 3(R): d)</li><li>• Making sure all students are focussed during the final plenary session (LO 3(R): e)</li><li>• Writing key language points on the board-negative (LO 3(R): f)</li><li>• Getting students to metacognise – why to you think that; do you agree with her explanation – why ? (LO 3(R): g)</li></ul>

### Appendix 3c(i): Lesson observation schedule for CASE lessons

Date 3/10/07 & 4/10/07, Teacher C, Observer ML, Class 7C, Lesson activity 1, No of pupil 24

[illegible]

## Appendix 3c(i): Lesson observation schedule for CASE lessons

Date 3/10/07 & 4/10/07, Teacher C, Observer ML, Class 7C, Lesson activity 1, No of pupil 24

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Strengths	Recommendations
<ul style="list-style-type: none"><li>• calm manner and approach with the class (LO 1(S): a)</li><li>• attempt to involve all students into the lesson (LO 1(S): b)</li><li>• good example to encourage students to bridge reasoning pattern to another context (LO 1(S): c)</li><li>• good questioning skills (LO 1(S): d)</li><li>• clarity about the task and therefore confident at responding to students' answers (LO 1(S): e)</li></ul>	<ul style="list-style-type: none"><li>• concrete preparation – make sure all the terms are explicit but through the students' answers (LO 1(R): a)</li><li>• visual aids – get a student to be a scribe (LO 1(R): b)</li><li>• classroom set-up – have the students centrally around the front (LO 1(R): c)</li><li>• pace of lesson – should be able to get onto word cards for most activities (LO 1(R): d)</li><li>• metacognition – ask why they think this? (LO 1(R): e)</li></ul>

### Appendix 3c(ii): Lesson observation schedule for CASE lessons

Date 12/3/08, Teacher C, Observer ML, Class 7C, Lesson activity 7 No of pupil 24 (approx)

[illegible]

## Appendix 3c(ii): Lesson observation schedule for CASE lessons

Date 12/3/08, Teacher C, Observer ML, Class 7C, Lesson activity 7 No of pupil 24 (approx)

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Strengths	Recommendations
<ul style="list-style-type: none"><li>• Good re-cap at the start of both lessons, including using the girl who was absent as a platform for other students to explain what had been done in the previous lesson (LO 2(S): a)</li><li>• Bridging examples used to engage the students e.g. clothes (LO 2(S): b)</li><li>• Questions asked to create the cognitive conflict when the students were explaining their classification techniques (LO 2(S): c)</li><li>• Good discussion about the difference between insects and birds (LO 2(S): d)</li><li>• Engagement with each group which allowed ideas to be drawn upon easily in the whole class discussion – this allowed similarities and differences in the way they were classifying to be highlighted (LO 2(S): e)</li><li>• Use of size and colour to create cognitive conflict with the classification activity (LO 2(S): f)</li></ul>	<ul style="list-style-type: none"><li>• Pace of the lesson – create challenge during the ‘number-crunching’ part of the lesson especially those that finish first- give it a time limit; make those who have finished help other groups (LO 2(R): a)</li><li>• Classroom environment – bringing the students around the front to encourage whole class participation (LO 2(R): b)</li><li>• Technical terms – mammals – possibly use examples like this to create consensus amongst the group (LO 2(R): c)</li><li>• Setting the task – possibly doing one example to ensure they are clear of what has to be done – not always appropriate (LO 2(R): d)</li></ul>



### Appendix 3c(iii): Lesson observation schedule for CASE lessons

Date 18/6/08, Teacher C, Observer ML, Class 7C, Lesson 15, No of pupils 24

This was lost after the lesson

[illegible]

### Appendix 3c(iii): Lesson observation schedule for CASE lessons

Date 18/6/08, Teacher C, Observer ML, Class 7C, Lesson 15, No of pupils 24

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Strengths	Recommendations
<ul style="list-style-type: none"><li>• Getting students to explain what the initial problem was so that everyone understood the scenario (LO 3(S): a)</li><li>• Getting students to discuss their ideas about the socks (LO 3(S): b)</li><li>• Hearing from all groups about how they solved the problem (LO 3(S): c)</li><li>• Setting the scene for the food scenario (LO 3(S): d)</li><li>• Using a range of questioning skills with the group discussion and remaining open to all their suggestions and reasoning (LO 3(S): e)</li></ul>	<ul style="list-style-type: none"><li>• Time – possibly too long on introduction – not always possible to get to all groups and the spinner example – quite a few groups had finished and were not doing anything for a few minutes (LO 3(R): a)</li><li>• Getting students to agree and disagree (LO 3(R): b)</li><li>• Asking students to say whether they found the task difficult or not (LO 3(R): c)</li></ul>

## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

It's the 18<sup>th</sup> of December. It's nearly 6 o'clock and I'm here with Teacher A. This is Martina Lecky and we're doing the first semi-structured interview at the end of the autumn term. So Teacher A I've got about 10 questions. It's a semi-structured interview which means that I've got questions but I might then ask additional questions based on your responses. You anytime can say you don't feel comfortable to answer a question and obviously do remember everything we talk about here now is not something I would ever use in my role as deputy head. This is about me being a researcher and a trainer. Ok so first question is: how would you compare your preparation for CASE lessons compared to other science lessons? Do you think there's any difference –time, effort etc?

I think there's a massive amount of preparation that needs to go into a CASE lesson compared to a normal science lesson. With a CASE lesson, after watching your CASE lesson I realised that to create cognitive conflicts I need to be able to prepare stimulus and a lot of activities that get them thinking. And then to be able to build on, you know to get them thinking about their thinking and the metacognition and be able to do the bridging. All of that requires, I feel, a lot more time than a normal science lesson. Even building the type of thinking in CASE lessons into normal science lessons I find, you know, is time consuming.

Obviously you were quite new to CASE when you joined the school and you started a bit last year with it. How has your understanding of the pedagogy that underpins CASE developed since September?

A lot now, I feel that I understand it a lot more after doing my lesson. I think when I watched you do the lesson, the demonstration lesson I thought I understood it and through reading through some of the notes in the front of the book I thought I did understand it. But I think until you do it and you then read back through those notes again and really have a reflection on what actually did you create a conflict? And when you're trying to come up with the phrases yourself; it looks a lot easier when you're observing the person that's doing it in front of you compared to what the reality of doing that in the classroom is.

So are you saying, like developing from that which is an interesting thing that I'm reflecting on, that part of the learning process with CASE as a teacher is that you need a bit of the theory then you've got to go and do it? You know I'm sort of interested in how much could somebody pick that up and do it on their own without guidance? How much do you need somebody training you?

Me personally I think I couldn't just pick it up and go with it. I think like the pedagogy you learn in university and then you need a lot of observation rounds, sorry a lot of observations and feedback. I feel with CASE even more so. Compared to last year I think the quality of what I could do now after doing a lesson and reflecting on that is 80%. Like it is, it's a massive difference. Because I don't think you're actually aware of how much is involved in a CASE lesson until you actually, until you are having to provide evidence that you actually, it's working, that the thinking about the thinking is...has happened and... yeah.

**Comment [MSOffice1]:** MF (E)  
takes a lot of time to prepare lessons  
E: 1

**Comment [MSOffice2]:** MF (M) +  
K&U  
modelling helped with understanding of  
methodology  
K&U: 1  
M: 1

**Comment [MSOffice3]:** MF (E)  
reiterates a lot of time to apply cognitive  
activities to other lessons  
same as E: 1

**Comment [MSOffice4]:** K&U  
understanding has increased through  
delivering a lesson.  
K&U 2

**Comment [MSOffice5]:** Reflection  
PoC: 1

**Comment [MSOffice6]:** MF (M)  
comparison + PoC  
through watching and reading she thought  
she understood but she needed to do it and  
then reflect; also much easier to observe  
than to do  
M: 2

**Comment [MSOffice7]:** PoC &  
MFs(O)  
can't just pick up folder; need a lot of  
observation and feedback and reflection  
O: 1  
PoC: 2

**Comment [MSOffice8]:** MF (O)+  
PoC  
by doing it she realised how much is  
involved, including evidence that it works  
O: 2

## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

**Great. Having attended the two INSET sessions of the autumn term did you find anything particularly helpful on a pedagogical level as well as on a practical one? Is there anything that sort of stood out from the sessions?**

Yeah I think when we went around the circle and we were asked “what did you do today that’s’ um what was the reasoning pattern that you used today?” For me that was very useful in that I had to think, first of all the terminology ‘reasoning pattern’ and thinking what is that and where am I using it? Because I haven’t used this terminology before and I think that’s part of the struggle too. I think the journals help with that.

**Which is, sorry to interject but it’s a bit like cognitive preparation isn’t it? A bit like with children, you know we make assumptions with our language so much don’t we? And they’ve already then, in my view sometimes switched off.**

Yes very much

**We kind of need to reflect on that when we’re training adults, we need to...**

Definitely, because if you’d run that INSET and I’d taken notes on that rather than you actually being practical about it and us speaking about what we were doing, and again me doing a lesson, me observing you doing a lesson really brings back that. I was in conflict watching you and I was definitely in conflict trying to do it.

**So then you’re sort of, if we’re thinking about one of the major aims of the programme is to get you to take ownership. Does that mean then in training sessions it’s really important that you are asked questions; you are made to reflect on your practice, your teaching more than here is a general thing?**

Definitely and I think there should be an expectation that we know the pedagogy from reading it and that we should be uncomfortable, we should be in cognitive conflict, which I really was not looking forward to, to be honest, in that first session. But I was expecting it somewhat and when it was happening I wasn’t comfortable but as I’m going through this process I’ve been, just the benefit of it, you know you see it with the students and so I think with staff it’s, we have to be able to do that to even somewhat understand what it’s like for them but also to be able to achieve the goals of what we’re trying to do.

**Have you used the Piagetian test data at all and if so has it been beneficial, has it been not that helpful? The test levels that it’s come out with.**

I haven’t used the test data, no. no I haven’t.

**You haven’t done, did you not have groups, did you not have buddies?**

No that’s something that I have commented on in my journal a lot. I didn’t use the test data, I didn’t. I did have them in pairs in my lesson and I spent a lot of time preparing the concrete operation or preparing the structure of the lesson. I need to; something I need to look at for the next lesson is that buddy system. Getting that correct for a start and then...yeah just the social mediation, having that play more of a part.

**Comment [MSOffice9]:** MF – INSET PoC & K & U found useful applying the reasoning patterns to science lessons K&U :3

**Comment [MSOffice10]:** MF (C) + PoC use of journal helps with terminology which was agreed to be like concrete preparation C: 1

**Comment [MSOffice11]:** PoC Agrees that understanding terminology is like concrete preparation for teachers PoC: 3

**Comment [MSOffice12]:** MF (C) INSET sessions – teachers being involved rather than taking notes C: 2

**Comment [MSOffice13]:** PoC & MFs (O&M) In conflict through watching demo lesson and in doing the observed lesson O: 3 M: 3 PoC: 4

**Comment [MSOffice14]:** A&B + PoC & MF(C) The learning for the teacher is uncomfortable because of the change, but is necessary and it helps with empathy for the students. A&B: 1 PoC :5 C: 3 SoO: negative side of initial phase

**Comment [MSOffice15]:** MF (E) + SoO – has not used knowledge of students’ SRTs Change s E:2 SoO: focus on teacher

**Comment [MSOffice16]:** PoC – use of journal

## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

**Are there any practical tips or suggestions you would like to share with other colleagues that you've gone through? Both general or specific about CASE lessons.**

Do you mean about the structure of the lesson or do you mean about the actual practical side...

**Yeah, anything, any sort of thing that you think "yeah I'd really like to share that with everyone from my experiences". Just like in general in lessons or in a particular lesson you experienced something and you think "oh I'd like others to know that".**

I don't know if it would be of benefit for others, maybe for beginning teachers coming in, for me definitely new to CASE I feel that you need to know that lesson and be very confident with that lesson. Much more than a normal science lesson, you cannot wing it at all. And you need to, I think have run through it for me before I was to do another observation, run through it a number of times to have enough confidence to allow the students, the focus to be on, because I find it quite difficult to work with the students' language and to be able to respond at the time effectively. That I find such a challenge that that needs to be the only challenge that's going on for me during that lesson. So that's probably what I would say to a new teacher to CASE.

**Yeah, so you've got to really understand how it's all going to flow so you can be confident on your feet and responding. So maybe that's part of why the development is the way it is because you need a few run throughs to know how it's going to pan out so you're not worried about how it's going to work. And then that means you can start refining the questioning. I mean that's why they say it's about a 2 year process so maybe that's sort of unpacking why it takes those 2 years really. Because you just need to get more and more confident with the flow of the lesson and it will work and when you do the oil. You know a reflection for me I was doing the oil one and they timed it wrong and it mucked up the data but I was able to blag it and play around with their data because, if that had been my first run through that would have just thrown me. So that's an interesting one, I've done that so many times I was able to improvise with the data. But as a new to it, it would have been "oh my god". So yeah it's quite interesting that being comfortable with all the doing activities. Yeah that's really interesting. Do you think the training programme is altering your approach to your normal instruction based lessons at any Key Stage?**

Definitely, I focus much more on the student answers and there's a lot more emphasis in my lesson planning on thinking about where I could ask the students to explain why. I think the biggest difference is....( 5 sec pause) I was trying to think of an exact example of the other day; I might have to come back to that.

**Yeah that's fine. Is there any particular area you would like more support with?**

Oh sorry, sorry what I was thinking was: when I did my lesson what I really noticed, this is the CASE lesson not a normal science lesson, I was confident only with the concrete operational and anything that felt recall, those basic things that you do in a

**Comment [MSOffice17]:** K&U + A&B – need to develop an understanding to have the confidence to do the lesson  
A&B: 2

**Comment [MSOffice18]:** MF (E)+ PoC  
Refers to the need to be able to respond quickly and that that needs to be the only challenge  
E: 3

**Comment [MSOffice19]:** Discussion – talking too much  
D: 1

**Comment [MSOffice20]:** PoC + MF (E)  
In lessons focus on students' answers which relates to planning  
E: 4

## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

normal lesson as soon as it was conflict as soon as it was me with metacognition or bridging because it's unknown territory those structures of what you're doing, like we were saying before, has to be very concrete. And I find in a lesson, normal lesson, if I know the lesson very well I find myself dipping into the CASE thinking.

**That's that same thing.**

Yeah

I think that's really interesting and I would say if I reflect on myself I'm probably the most CASE like in the subjects I'm so comfortable in and have taught so much. I can be much more playful in how I do things. And I do a lot of that "do you agree, who disagrees" and I do that now as just part of my (inaudible 12.15) especially where I know there's a conflict. And my Year 12s are even using that language which they know. They'll go "oh miss we're having a cognitive conflict now" because I tell them about CASE and about...so it's quite interesting. Is there any particular area you think you would like more support with? Like something you feel: the pedagogy, the practice, that, is there anything you particularly think, other than what I'm saying we're going to be doing, is there anything you think "oh I'd like that" or..?

I think the bridging I find...or even the emerging at the start, both of them. Because I'm reading the CASE lesson instructions like a manual the kinds of stimulus, this emergent that you can get the students into to make it exciting at the start, I think there was an example that you gave the next day you said worked really well with the sausage.

**Oh yeah**

That's something I'd like to hear about because I was thinking in my observation to stick very much to the book which I don't think I ever do in any normal lesson. I do try and give a wow factor. And the bridging I've got this, in my mind it's set as concept mapping and making links to you know something outside of whatever it is we're talking about. And beyond concept mapping I'm limited as to ...

**Other contexts that you could bring it to?**

Yeah

**That's brilliant. Ok I'll have a think about that and the hooks that bring them in. yeah ok. Do you use your journal and how, if you have or haven't how helpful have you found it or not found it? Or do you think it would be a useful tool hence you've got the old journal in your hand?**

I've put together in the journal, for a start what I found useful was to take, and it is like concrete operational really with that thinking note taking. Your proposal that you handed out at the beginning I made notes on that sort of Vygotsky and Piaget model in my own words and that was useful. Then to reflect on the lesson that you did and the lesson that I did and just to have, just to keep in order any of the things that we've done. So it has and I think that definitely the way, forcing yourself after, because I felt

**Comment [MSOffice21]:** A&B, PoC and K&U  
Has the confidence to use the CASE pillars if she has the knowledge/understanding of the concepts.  
A&B 3

**Comment [MSOffice22]:** Discussion – too much talking by me  
D:2

**Comment [MSOffice23]:** MF (E)  
Acknowledges that she uses the instruction booklet like a manual; Wants to be able to adapt the lessons,  
E: 5  
SoO: initial mechanic use

**Comment [MSOffice24]:** MF (E) & SoO  
Acknowledging that she is like a novice which is not the case in other lessons; recognises she wants to adapt  
E: 6  
SoO: exploring & bridging

**Comment [MSOffice25]:** K & U  
Used journal to makes notes on psychological models  
K&U 4

**Comment [MSOffice26]:** MF  
Used journal for reflection of observed and demo lessons  
PoC: 6



## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

it went very badly on my lesson observation. So the amount of things that I could come up with after I'd done such a bad lesson in my eyes of ways that I could improve it through looking back to what is metacognition and how you're supposed to get that and what is, how do you create the conflict and maintain it? Because what I found out within my journal when I was writing in is my biggest struggles were to maintain that level of cognitive conflict, to keep it there.... (rifles through journal)...Oh...I can't find it but it was to do with the struggles that I found and being able to maintain that level of cognitive conflict and this, the constructions zones. Being able to moderate in a normal classroom I think is difficult. Being able to moderate in a CASE lesson is, to a beginning teacher it seems impossible. What I really, that difficulty increases so much to each individual being able to pitch what's, where they're at, what level they're at and move into the next level with key phrases like "do you agree". That whole, the skills involved to do that and I did see it evident when I was watching your lesson. That's why I said in the INSET that I saw so much going on and I could see it going on but I couldn't, my ability to do that while I was teaching the lesson was, I couldn't do that at this stage. So I can see it could be done but that was my trouble.

So it's now, is the important thing then that you see where you want to go and that's what's helpful about a demonstration lesson, that you can see what and where to get to? But I think something that I would say to you is to reflect on, you know, I will like I did a demonstration with Tom's group and I don't feel it went as well. So you know, it was a double lesson, it was in the afternoon a couple of children were, it's quite a handful class. So it's interesting how you know, it doesn't, I think your reflections on how lessons go can vary on the whole. You know and I think you might sort of have this up here and then suddenly it doesn't quite match what you were hoping for. But I think it's really interesting what you said about; initially need to see that lesson through and you need to get used to that to then, it's sort of like layers to your, it's a layering effect. You're kind of like putting this level on and that level on.

Yeah see I think that was a lot for me to take in. that when I was observing you to write in what you were doing and it was all going on at once. I think that was always for me, that's how I became too much. But when I, because the reality of you teaching it individually, moving them up individually it kind of does have to work, you go with the flow once you're in there, that's. I think the group I've got, I've been very fortunate because it's a group that I could

**Yeah**

You know easily...

**Yeah absolutely, no they're absolutely wonderful. Are there any things you find particularly difficult when teaching CASE other than things we've touched upon already?**

Definitely just the, going back to the struggles of, for me it is that lifting a student from whatever level they're at to the next level. Is that, am I with my practical demonstration creating a conflict for everyone here and maintaining that level. When I was doing my demonstration I felt the entire time that a third of the group were over,

**Comment [MSOffice27]:** A & B  
Felt observed lesson went badly and used journal  
O: 4

**Comment [MSOffice28]:** MF(E)  
Refers to being to adapt as a novice in CASE lessons is virtually impossible  
E: 7  
SoO: mechanic use

**Comment [MSOffice29]:** K&U & MF  
reflecting on lesson in terms of methodology in journal  
Demo lesson saw students being moved to next level - struggling  
K&U 5  
M: 4  
PoC: 7

**Comment [MSOffice30]:** MF (M) & PoC  
Demo lesson made her reflect but realises there was too much going on but she was unable to do that because of the stage she was at  
M: 5  
PoC: 8

**Comment [MSOffice31]:** Discussion – too much talking  
D:3

**Comment [MSOffice32]:** Same point as above about demo lesson

## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

could be metacognising and this group over here were only just understanding what I was doing. And I, my basic confidence of what I was doing too was a bit shaky. But yeah I think I was thinking a lot about their thinking and that for me was becoming a bit too much, at the same time thinking about how to respond to their responses. That's a real art that I think. And I think also it's a very, it's like a comprehension ability that I would have to develop stronger to be able to, I think in any lesson when a student gives me an answer to think on my feet fast to give back. I often ask them to repeat it. (inaudible 20.42)

**Comment [MSOffice33]:** MF (O)  
Recognises the difficulties of maintaining the cognitive activities during a demo  
O: 5

**Comment [MSOffice34]:** MF (E)  
recognises the intuitive practice of responding quickly to students' responses  
E: 8

**No absolutely, it's a real speed of response isn't it? Yeah, no I think that's a really interesting point. Is there anything that you would like to mention that you haven't been able to mention through this interview?**

Just that I think it would be really beneficial, I know time probably makes it difficult, but to see again, because I wrote in the journal that one of the things I think would be of benefit is if I had a video to, when you did the demonstration lesson. So I can pinpoint that was metacognition happening there. What did you do leading up to get that? And how would the students, how are you maintaining that level? Those sorts of things.

**Comment [MSOffice35]:** MF (M) & PoC  
Need for another demo lesson to help see teacher's practice in relation to cognitive activities  
M: 6

**Well we videoed the last lesson I taught with Teacher B was videoed and I'm going to edit it and hopefully have it ready for the next INSET session. So that's my aim. So it wasn't as I said for me, I feel the best lesson. So that will be interesting, but like your one it did go exceedingly well I felt on reflection. So that's going to be interesting for me. It was still, I feel happy with it but there were, you know, again we went off on a huge tangent. But again I feel it was a well worth huge tangent to go off on. So that will be interesting but if you feel, you feel your development would help with another lesson with me, you know, before the summer term then we can do that. So that's where I said "if you want something different to other than that, that's between you and me to set up". So I think let's see what you feel after you see the video which I hope will be ready.**

**Comment [MSOffice36]:** Discussion – too much talking  
D:4

Yeah because I think that's what's the beauty of the video is you can make it stationary.

**Yeah**

And you can say "that's when I've done, that's metacognition there". Because that was my struggle yeah you doing the demonstrations that I just want to scribble down.

**Well that shows you then that that piece of paper isn't very helpful for a novice it's a, for me helpful, but not for a novice. So I think that's a good thing for us to reflect on and interestingly you know, I've seen that through the three of you. That's not yet something that's overly, I think it's a helpful framework to look at, the things that characterise those things. But it's a bit too much on top.**

What was really helpful when I was observing you was I took notes on, I wrote down the phrases you said during the lesson. And those phrases that you used to create cognitive conflicts were on one page and then I did also what you did with the



## Appendix 4a: Transcript and Analysis of Interview I of Teacher A

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movement around the room. You moved them around you or what you were doing to create metacognition. I tried to just get down phrases.

**That's great. Well thank you very much Teacher A for on the penultimate day of school being here. So I appreciate that, we did 24 minutes, thank you very much.**

No worries.

**Comment [MSOffice37]:** MF (M)  
Demo lesson allowed her to reflect on specific parts of CASE methodology  
K&U 6  
M: 7

## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

It's 3 o'clock on the 13<sup>th</sup> of December. I'm Martina Lecky and I'm here with Teacher B and we're having our first semi-structured interview of this research programme. So name I've got 10 questions and please at any time feel free to go off on a tangent, to ask for clarification and because it's semi-structured it will mean that I might ask a further question based on your answer if something of interest comes up, something that I want to develop that idea or talk a bit more about it.

Yeah sure

And if you in anyway don't feel comfortable to answer anything please don't, just, no judgement will be made if you say "I'd prefer not to answer that". And obviously just again to reiterate this is about the research it's nothing to do with my role as a deputy head. Ok ready to go. So first of all how would you compare your preparation for CASE lessons as well as science lessons both in terms of this year particularly but also experiences when you've taught it last year?

Yeah I mean I've obviously being part of this research has kind of given me a bit of a kick into thinking right I need to be putting more effort into the work that I'm doing with all these CASE lessons. I suppose if I was being honest in the past because there is quite a rigid framework and you get a file and you get all the lessons, all the extra equipment comes as one set piece, I've obviously read through the lesson but haven't given it, probably, a great amount of thought about you know what was the conflict that we start off with and where was the, um what other examples might I use or whether I was happy with the examples they were giving and how. I suppose really just thinking about the lesson progressing from one stage to another. I would just go in and because you know because in the actual framework it says 'start off with this and then go on to this' and I'd pretty much just do it as rote. But now what I'm tending to find myself doing is very much thinking about, having read the lesson, how I would tailor it to my own style of teaching. But you know what's the catch? What's the story I'm going to tell them? Not necessarily immediately but certainly within the opening to catch them and to start getting them thinking about the concept of probability or ratios or whatever it is. And also just thinking, being more critical I suppose of the lesson. Where as before I really wouldn't deviate from the lesson at all, because I didn't know very much about it I was very hesitant to move away from it. So I'd, even though I was unsure whether it was going to work or not I would've just done, I would've carried out, if it said 'have a 5 minute pause' I would have done it even if I didn't think it was going to work necessarily. Now I'm a lot more critical of that and because I'm, it's probably to do with the confidence that I have in my own ability to carry a CASE lesson. And if I don't think something's going to work or it'll work in a particular place in the lesson I'll move it or I might not even use it at all.

**Comment [MSOffice1]:** MF (E) + SoO  
Initially used it like a rigid framework and hadn't thought about it much in terms of conflict and whether or not to adapt.  
E: 1  
SoO Survival

**Comment [MSOffice2]:** MF (E) + SoO  
Now thinks about how to adapt to relate to his style of teaching, especially the use of an opening catch.  
E: 2  
SoO Exploring & Bridging

**Comment [MSOffice3]:** A&B, MF + PoC, + SoO  
Now more critical of the lesson because of confidence in his ability to do a CASE lesson  
A&B: 1  
E: 3  
PoC: 1  
SoO – more critical relates more to adaptation

## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

**So do you think, just to sort of clarify for me. Do you think therefore, obviously you're changing your preparation. Is that preparation more or less than a normal curriculum lesson or does it just depend?**

Oh I see what you mean.

**Would it be, for instance, you know, now you've taught CASE more than once and you've taught another curriculum lesson more than once, you know, is there an easy way to make a comparison or do you think it just is dependent on too many other factors to generalise?**

Well no I think you probably could generalise, I'm just trying to think really. I suppose, I mean it's a little bit unequal because if you were to take just a normal lesson, like on light for example, I have taught that quite a few times so it's a bit unequal. But I suppose if you were to say to me if you'd taught I don't know CASE lesson 18 twice and another lesson, I don't know let's say on light twice. If you're going in to teach either of them for the third time, would you put more effort into a CASE lesson or a normal lesson?...I don't know, it could be about equal actually, it probably wouldn't be a lot of difference between the two. Well yeah it would depend. I mean obviously I suppose biology, I'm probably more confident in biology and physics. So if it was a GCSE chemistry lesson let's say and a CASE lesson on probability, which I think are sort of more difficult lessons, then I'd probably put a fair amount of effort into both of them. And I would just plan until I was reasonably happy that I had a lesson that would work I suppose. So yeah, I don't think I'm in a position where I would say that one was necessarily taking up more time than the other. No, not really, not necessarily. (5.34)

**Great, that's really helpful. Has your understanding of the pedagogy that underpins CASE developed since September?**

It has actually, yeah. Because I remember, you know having been at King's I obviously knew the basics, but I suppose I'm not one to really pick up too much on the detail but I'm very much the kind of person that will make sure I understand the practical side of things and then the theory behind it I'll kind of catch later, at a later point. And I suppose that that later point is gonna come now, so yes. But also it's interesting because I suppose as I've hinted I'm obviously thinking about and planning lessons more now because I'm doing them for the second or third time but also because of my research. And so yeah obviously when you're doing it you start to think 'well why am I doing this?' obviously, or 'why, I wonder why they've put that there in the lesson'. Of course when you start to think about the different stages within the lesson then it starts to make a lot more sense as well. So...

**Comment [MSOffice4]:** MF (E)  
Time spent planning normal and CASE lessons about equal.  
E: 4

**Comment [MSOffice5]:**  
MF(E)  
Same as above in terms of planning

**Comment [MSOffice6]:** K&U  
From PGCE knew the basics but not he is not one to focus on too much detail  
K&U: 1

**Comment [MSOffice7]:** K&U + PoC  
Practical side comes before theory  
K&U: 2

**Comment [MSOffice8]:** K&U + MF (E)  
In planning is thinking more about the purpose of the activities which helps it to make more sense  
K&U: 3  
SoO: more exploring & bridging

## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

And following on from that, having attended the two INSET sessions was there anything, I mean you have given feedback to me already, but is there anything right now you can remember on a pedagogical level or a practical one that are things that you've taken away from any of the INSET.

Well I think I hinted at it before but you know, I suppose when I started learning about CASE and I started teaching a few of the lessons I was very much set in that, you know, concrete preparation then some kind of conflict, then you were going from one stage to the other. And having listened to what you were saying and also I watched some of your lessons I realised actually building on previous lessons, well maybe not even necessarily, you could actually start with a bridging idea, you know it's not, you don't have to go step one, step two, step three, step four. You can play around with it and it just really depends on the class that you've got and what they've done before and I suppose an idea of where you want them to go. So that's certainly one thing that I've taken from what we've been discussing. But also the idea of, and I know this is obviously very important in normal lessons, but I hadn't made the link between the normal lessons and the CASE lessons, but just having that catch, that kind of little story, it just seems to work. It seems to work better actually in CASE lessons in many respects than in many normal lessons actually. Once you've got that and you're able to get them into that, thinking about that concept it just seems to make then approaching other, you know the same idea within different, no same concept with different ideas a little bit easier.

Just developing on that catch idea, can you think about why, have you thought about why it works so well with the CASE, the catch?

Well I have thought about it a little bit actually and I think I came to a very quick conclusion that it was to a large degree with CASE it's a lot of; I'm trying to think of the word, um, this is going to sound a bit silly really but you're kind of using your mind a lot. It's that, you know it's a lot of, you know the whole idea of having the preparation and then the conflicts, all that conflict is going to occur really within the mind. Whether it's the children's or yours in some cases. And I suppose you can start off the lesson by using your mind, even in a really small way, even just on the imagination side of it. And if you tell them a story it's nothing, there's nothing, ok you might have a prop or something, but there's nothing there so they've got to imagine it and they've got to use that kind of construct to then think about the concept that you're trying to get across so probability, ratios, whatever. And so by already starting to get their minds going with the imagination and thinking about the story and then oh what's changing or whatever I think it's just a bit of a kick- start really. And because they're already using their brains then just taking it a step further to the conflict or whatever it is, I don't know I suppose in a strange way I just thought about it like that really. If you put something in front of them like a beaker and a Bunsen burner; sure they can start thinking about how you can approach an idea or a concept or a bit of conflict. But I don't know, for me anyway if you just start getting my imagination...and sometimes I will physically close my eyes when

**Comment [MSOffice9]:** MF (E) + PoC  
Reiterates point about that when he started teaching he went from one stage to the next in terms of lesson plan, referring to some of CASE pillars  
E: 5

**Comment [MSOffice10]:**  
MF(M) + PoC + K&U  
From discussion at INSET, demo lesson and watching videos, now knows that you can adapt lessons especially in relation to cognitive activities  
K&U: 4  
M: 1  
PoC: 2

**Comment [MSOffice11]:** MF (E)  
Has been using the 'catch' at the beginning of lessons which is works well and relates this to students finding it a bit easier.  
E: 6

**Comment [MSOffice12]:**  
A&B  
The conflict occurs in the mind – for students and sometimes teachers  
A&B: 2

**Comment [MSOffice13]:**  
A&B  
The 'catch' at the beginning kick-starts their imagination  
A&B: 2 as above

## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

I'm trying to think, you know trying to resolve a bit of conflict. And I just thought that by tuning into that at an early stage with the story and a bit of imagination that would help that. I don't know

**Comment [MSOffice14]:** Same as above  
A&B: 2  
SoO adaptation – is able to be reflective of use of innovation

**It's interesting...something to think about .... I haven't got my own answer for that either but yeah that's something I definitely like doing. Have you, question 4, have you used the Piagetian data at all and if so how have you used the information in lessons?**

I haven't used it a lot I must confess. I suppose it's been a bit of a CASE of trying to walk before I can run, a little bit. So I'm just trying to make sure, I think the lessons, I've been trying to get those sorted out so I haven't been paying too much attention to the levels and say for example if I'm asking questions, who I'm aiming that question to. Although I have looked at the levels and I have got a rough idea of which individuals are in the lower levels and which ones are in the higher levels. And also I have actually grouped them into small groups; 2s and 3s in similar levels as well.

**Comment [MSOffice15]:** MF (E)  
Hasn't used the SRT data a lot– links to walking before you can run, but has considered the SRT levels for groups  
E: 7  
SoO – exploring & bridging – focus more on teacher than on students

**So they know?**

Yeah but again I haven't used those very often, it's just, it just hasn't quite worked like that yet but I'm, so if I have got them and as I say I will try and, so say for example if I'm, if I know the question I'm asking is quite a tricky one so it's building the conflict maybe. Then maybe I'll try and home in on someone with a higher level. Or if someone, somebody's answered a question but hasn't got it quite right and a lot of hands go up to try and, so what do you think was wrong with their statement or how would you improve it, and I'll try and make sure that the person I go to next is of a similar level, I won't try and jump too much. But that's about it if I was being honest really.

**Comment [MSOffice16]:** MF + K&U  
Has an awareness of SRT levels and types of questions students are likely to be able to answer  
E: 8

**Are there any practical tips or suggestions that you've used that you would like to share with colleagues? Both kind of general and specific about CASE lessons.**

Just really, if someone was coming to me now I'd just, I suppose I would just reiterate the ones I've already mentioned really so you know the lessons have obviously been developed by people that have thought very carefully about the way the lessons have been set out. But once you've gained a little bit of confidence not to be afraid to play around with the content of those lessons a little bit and to feel free to add a catch or something like that at the beginning. I mean I suppose I'm saying I was so rigid with them to begin with and now I realise I didn't need to have been and I can play around with them a little bit. And I suppose I just wanted to let, convey that to the person that was starting out. But I suppose that the main thing I would say which I'm still, everyone struggles with is just to start talking really and just let them, let them discuss, you know give it over to them a little bit really. Because I still find that quite difficult and I think it's always the thing that teachers are going to find quite difficult you know just letting them, and even if they're going in completely the wrong direction you've got to let them go in that direction because otherwise the conflict will still be there and they won't come to some kind of resolution. But it is very difficult and, I mean I

**Comment [MSOffice17]:** A&B + SoO  
Once you have gained some confidence you can adapt the lessons. E.g. at a catch  
A&B: 3  
SoO: once you gain confidence try to bridge/explore

**Comment [MSOffice18]:** PoC + MF(E)  
Knows he was too rigid to begin with and felt he didn't have to be  
E: 9  
SoO: everyone struggles –survival stage

**Comment [MSOffice19]:** K&U PoC + MF (E) A&B  
You need to hand it over to the students and allow them to go off at tangents; everyone struggles with it and it is difficult  
E: 10  
A&B :4  
PoC: 3

## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

just say obviously watch people that know what they're doing because that's really the only way that you're going to, to learn how to let them talk but at the same time it's a way of, a skill of being able to let them say what they want to say but also with, let everybody within the group have a say as well. But also do it so that they will eventually start to come round, hopefully in a bit of an arc, they will come back hopefully to where you want to be. But it might take a bit of time.

**Comment [MSOffice20]:** PoC + MFs  
To learn you need to watch experienced practitioners to be able to hand it over to the students  
M: 2  
PoC: 4

**I think you picked up on two interesting things there which is the, a question I think is really interesting about, you know, if you were to hand over the folder to somebody, you know, your answer makes the assumption that, which I think most people would agree with, that people would keep to it very rigidly. And I'm interested in why, we know that would happen don't we? And you then in your, a bit later you talked about that you kind of need that expert and that's what I'm quite interested in. Do we need that or could somebody, eventually over time, develop it without the appropriate, you know make those adaptations without having to be told to?**

**Comment [MSOffice21]:** MF (E) +  
Hopefully the discussion goes around in some kind of arc but takes time.  
E: 11

I think they would do actually. I mean I think, especially with teachers I mean, I mean I think I mean up to a point obviously. I mean I think the early lessons I think didn't go very well and I think that was for a number of reasons but I think one of the reasons was because I was sticking to the framework too strictly. If I'd been a little bit more, well I suppose gone with my own gut feeling really, which is let's face it what you really need to do anyway, then lessons would have gone a bit smoother. And I think I would've realised where those lessons were going wrong eventually. It probably would've been, it probably would've taken a bit longer to sort those things out. But I think I probably would've got there in the end. But some of the schools, having said that, like just, I don't know I can't really describe it, but just watching somebody that's really good with a group involving, actually saying very little but getting them to put forward all the ideas and all the information and also involving everybody in the group. That is quite a skill and I think something like that you do need to watch somebody, or I certainly would do anyway, in order to get that, at least part of that skill. But I think some of it you probably would've done but it's like anything you get there quicker than normal if you're able to watch somebody that knows what they're doing.

**Comment [MSOffice22]:** PoC + MF (E)  
Initials lessons didn't go too well because of sticking too rigidly to framework. Would get there in the end but need to watch someone who is good  
E: 12  
PoC: 5

**Great. Do you think the training programme since September is altering your normal approach to instruction based lessons in anyway?**

**Comment [MSOffice23]:** MF (M) + PoC  
Emphasises the importance of watching someone and recognising the skill of handing it over to the students  
M: 3  
PoC – same as above 5

Yeah that's a good one. I think it is actually. I have found myself recently, whether I like it or not, definitely throwing it open to the class more. I've, you know, stopped talking so much and then thinking 'well this would be a good place to see what they think'. And also just little points I've, I'm trying to think of an example, but if, if one of them gives an answer and there's a small mistake instead of just actually correcting it there and then, which I think I probably would've done earlier, I'll say "well that's interesting, that was a fantastic answer but there was just a tiny, I'm being really pernickety, there's a small little error" I won't say it but I'll pass it over to them and, it's just I'm kind of throwing it back to them all the time. And even though I did that a bit in the years gone past I don't think I did it quite as well as

**Comment [MSOffice24]:** PoC + NC  
The teacher may develop the skills but it would take longer compared with being able to watch someone doing it.  
PoC same as above



## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

I'm doing now and I think that is largely down to CASE and the lessons that I've seen with you and also on the video and other sources as well. So I think, yeah it is kind of creeping in. And also the whole idea of, I haven't really done this very well but it's an interesting one and I would like to do it more, is where, and I've seen it done not just in CASE actually but one or two other examples, where you start off with just a challenge really. A conflict, change call it whatever you want and by the end of the lesson they need to have tried to have thought well why it's happening, they need to have evidence for what's happening so that if they were to leave the room and then explain to somebody else they could do that with the data they've got. So you know that's, I mean I know it's not quite the same thing but there's a lot of evidence of CASE in there as well so just getting my old brain thinking. Yeah, definitely with the passing it back to them and the questioning and involving the class and not just telling them the answer, that's definitely come from CASE.

**Is there any particular area you think you would like more support with or development on. Is there anything you sort of think, you know, I'm interested in that or I think I need some, you know, development here. Is there anything that springs to mind? (19.54)**

Not really, I think at the moment I'm just at that point where I've, I suppose I've learnt bits about CASE and I've realised that there are things that I need to be doing in my CASE, not just my CASE but elements of my other lessons as well, and at the moment I'm just starting to incorporate those and just trying to make sure my CASE lessons I'm teaching at the moment as best I can. But that incorporates so many little skills and things that I've learnt over the last few months. I'm not too sure I could really pinpoint just one or two. But I suppose the thing that I'm working on at the moment is (inaudible 20.46) something you could work on for a long time but just that whole involving the whole class and just letting them do the work really but at the same time as the teacher just trying to make sure that the lesson is going in the direction that you want it to. And I'm starting to get that skill, I think, but again it's something I need to build on I think.

**Do you use the journal at all, and if you have do you find it helpful? Or if you don't is there a reason why?**

I haven't actually. Why haven't I? well ... I've got um, I suppose, this is going to sound a little bit strange but in the past I've written lots and lots down and made myself little lists and I've written (inaudible 21.44) well I haven't kept a diary as such but. And I've never really thought that it got me anywhere really to be honest with you. I seem to be writing lots down and it never seems to really get me anywhere. So I'm kind of anti at the moment with the writing. So I've, so that's kind of, and then what with time etc. So I haven't really written lots down but I do think about them quite a lot actually. Do you need me to say anything about overall thoughts or...?

**Yeah**

**Comment [MSOffice25]:** MF (E) & PoC  
The approach is 'creeping' in to other lessons especially asking the students what they think  
E: 13

**Comment [MSOffice26]:** modelling  
M:4  
PoC 6

**Comment [MSOffice27]:** MF(E) + K&U  
Starting off with the challenge – hasn't done it too well but has seen in CASE and other examples and relates it to students being able to use the data to explain the resolution  
E: 14

**Comment [MSOffice28]:** MF(E) +K&U  
Reinforces that CASE is about questioning the class and not telling them the answer  
E: 15  
K&U: 5

**Comment [MSOffice29]:** PoC hasn't used the journal as writing things down in the past hasn't really got him anywhere  
PoC: 7

## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

Well I mean I just just really I think we've touched on most of things already so far, just the idea that I think it's really advancing some aspects of my teaching and more importantly as far as I'm concerned it's those aspects of teaching that I think were, were getting a bit stale quite frankly. And I think that, well that's been proved in many, many cases that teaching and learning at the end of the day is a lot better when there has been that conflict or that challenge. And in that, in all the CASE lessons that's really what you're striving for. And I think that's coming through in some other lessons as well so I've been really pleased with that.

**Great. Are there any things you find particularly difficult when, I mean you might feel we've covered this and do feel if we have already. But is there anything or things that you find particularly difficult with CASE lessons?**

No not really I suppose, as you've kind of hinted, well I won't say everything but I mean it's the whole package really. It's just trying to, I don't know really, there's such, I think the problem that I have in a way is there such good, you can see where they're such good lessons and incorporate so many things that are, you know, I think you have to hold really in high regards the whole idea of a challenge and a conflict and as a team they will try and work through the conflict or conflicts within the group. And to a large degree I just, I suppose it's a bit of a personal thing where I just think well in a way I'm not doing the lesson justice. I mean I don't beat myself up about it but it's just, I just feel like I'm letting people down a bit because I'm not doing the lesson as well as I could be. And so I'm just very keen to make sure that I try and learn so that I can do those lessons as well as I should be. But um...

**Do you think you're being hard on yourself?**

A little bit but I don't think that's any bad thing. But yeah I do find them hard and I still do find them hard and there are one or two, I mean I'm trying to think now but with the, with the Year 8s there were one or two, or maybe it was the Year 7s, I can't remember now. There was definitely one lesson where I physically broke into a cold sweat and I haven't done that for a little while. Just because I couldn't, they were building great but just going in completely the wrong direction and we had been going in the wrong direction for a little while and I tried to turn it but none of it was working and I just couldn't see any way, without actually saying the answer, how we were going to get out of this. We did in the end but yeah, it wasn't...

**But how did you in the end?**

I'm trying to think now. I think actually I was very lucky because, no that's right, because I suddenly realised ok this example isn't working so I said "well ok we might come back to that example in a moment". I gave them another example which was probably going to be easier for them to, it was that one actually where, it's one of the first ones. It might be the first lesson actually. Where thinking about the berries or the coldness of the winter and the berries on the bushes. And so we were doing the examples that, and I was still in my very

**Comment [MSOffice30]:** MF (E) +PoC  
Recognises that his teaching is changing which was getting a bit 'stale' and is pleased with changes. Focus on conflict and challenge in CASE is coming through in other lessons  
A&B: 5  
E: 16  
K&U: 6  
PoC: 8

**Comment [MSOffice31]:** PoC + MF (E)  
A&B K&U  
Recognises a difficulty is that there are so many aspects to the lessons which he holds in high regard  
K&U: 7  
A&B: 6  
PoC: 9

**Comment [MSOffice32]:** PoC + A&B  
Acknowledges that he doesn't think he is doing the lessons justice and knows that he has to learn to do so  
A&B: 7

**Comment [MSOffice33]:**  
A&B  
Acknowledges that he does find them hard especially some of the Year 8 lessons  
A&B: 8

**Comment [MSOffice34]:** PoC + MF (E) & A&B  
Recalls one lesson where he found it very difficult because the students were taking it in the wrong direction and he couldn't turn it around.  
A&B: 9



## Appendix 4b: Transcript and Analysis of Interview I of Teacher B

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strict mode where I was following the framework. And I was doing that and they weren't, of course the, I mean, they just weren't really getting it and they were going off on a few tangents. They were trying to explain them but they weren't catching on the whole idea of one fact having an effect on another. And I can't remember the example that I gave now but I just remember thinking these are obviously berries on bushes and stuff it's just, they're not quite with me. So I just, I can't remember what example I gave them now but I just gave them an everyday example where the...

### Girls and the bag?

It might have been that one actually I can't remember now. And then, they quite quickly started to get the idea of where I was going. So I just needed to change the example. In fact if I'd gone with that example initially then actually it would have been a lot smoother but yeah I remember thinking I'm not quite sure I like this.

**Finally, is there anything else you'd like to mention that you haven't had a chance to at this juncture? Or anything you'd like to ask?**

No not really I think that's everything it's you know, no that's fine.

**Great well thank you very much Teacher B it's been a pleasure talking to you. Thank you**

**Comment [MSOffice35]:** MF (E)  
Eventually was able to think of a different example  
E: 17  
PoC: 10

**Comment [MSOffice36]:** MF (E)  
Acknowledges that if he had thought of a different example it might have gone a lot smoother.  
E: 18

## Appendix 4c: Transcript and Analysis of Interview I of Teacher C

It's the 14<sup>th</sup>, 13<sup>th</sup> of December 2 'o' clock in the afternoon and I'm with Teacher C and we're doing the first semi-structured interview for the research based thesis and Teacher C is one of my participant teachers. So just to let you know how I've set up the interview Teacher C. I've got 10 questions and please feel free to answer as you like and ask me questions if you're not sure what I'm asking. If you don't feel comfortable to answer then obviously feel free to say "I don't feel comfortable to answer". And obviously this is all about your professional development within the context of the research not about anything with respect to school and, you know your professional development. So please feel free to speak as openly, I am a researcher in this context not in any way part of the senior leadership team. And then at the end I'll obviously ask if there's anything you'd like to mention that you haven't had a chance to mention. Ok so the first question is: how would you compare your preparation for CASE lessons to other science lessons? And please feel free to talk about in previous Years, in general and obviously this Year in particular.

Ok, I think when I first started doing CASE I really had to put a lot of effort into reading through the lesson plan several times, checking I understood what the thrust of it was, checking if I thought the activities would work with my group or with the layout of the room and really thinking about the actual mechanics of it as well as thinking about the purpose of it. And sort of watching out for black spots where I might inadvertently 'give the game away' during discussions and also where the kids might get lost. Whereas normal lessons tended to be much more 'what was the content? So now how can I go about doing the content?' The CASE lessons was more a case of 'how can I adapt what's already been suggested as an activity to make sure that it fits the purpose'. So it was sort of looking at it from the other direction I think at first. And then as times gone on with the CASE lessons because I can understand more about the purpose of them and I've done a lot more work on my MA about the work of Piaget the work of Vygotsky about social construction, about the ZPD and cognitive conflict. I think I've understood better the purpose of them now. So that I feel a bit happier about changing activities or cutting out a bit of an activity, understanding the theory more behind it. And because I've done CASE continually without any breaks, this is now my 7<sup>th</sup> Year of teaching CASE, I don't feel I need to put as much preparation into the lessons because I know straightaway what the lessons are and what the idea of it is, what the equipment is, what works, what doesn't work. So for example the chogs one, I know it's a pain so I'm already looking out for that before I even walk into the room, but without having to actually read up on it. What's different this Year particularly is that my Year 7 group with the CASE isn't a teaching group. I don't teach them except for CASE. And so I find that, I find that really weird – not knowing their names still because half of the lessons have been taken by you. And so I've actually only taught them for 4 or 5 single lessons all term which seems really weird and I've never had that. I always thought that CASE was quite a good way to build a relationship with a class but actually now that I'm in a situation where that's the only thing I'm doing, it's not that easy to build a relationship because you sort of feel like you've constantly got to move on and keep the pace up and there isn't the time like there might be in a normal lesson where you've got time to do 'right 5 minutes lets answer questions' and go round and chat to them. So I feel like I know them much less well. And in terms of knowing the ones, I've got obviously their CASE pre-test results on paper, but because I don't see them

**Comment [MSOffice1]:** PoC & E  
Initially a lot of time needed to be put in.  
E: 1

**Comment [MSOffice2]:** K&U  
Checking she understood the trust of the lessons  
K&U: 1

**Comment [MSOffice3]:** K & U + MF(E)  
Relating theory to practice  
K&U: 2  
E: 2

**Comment [MSOffice4]:** E  
In planning thinking about discussion and where she might give the game away  
E: 3

**Comment [MSOffice5]:** K&U & MF(E)  
Refers to adaptation in considering are the activities fit for purpose and then how she understand the purpose – interesting comment – she is happier to adapt because of her understanding of the theory  
K&U: 3  
E: 4

**Comment [MSOffice6]:** K&U & MF(E)  
She has been teaching it for 7 years so she knows what works with specific reference to equipment. This has reduced planning time.  
K&U: 4  
E: 5

## Appendix 4c: Transcript and Analysis of Interview I of Teacher C

outside of a CASE context I don't know their abilities. Which is maybe good because I'm not pigeonholing them before I even go into the CASE lesson. Because sometimes kids do surprise you in CASE lessons and so it's quite nice that I haven't already got an automatic 'they're the bright ones, they're the one that's always going to find it difficult'. But it's weird not having that background about them.

**Yeah, I'd like to ask you that so I, that's part of being semi-structured we can go off on a tangent. Because I'm really interested by your answer about that previously you felt you built your relationship often through the CASE lessons rather than, is that as opposed to through the normal instruction based ones or, you know, could you expand on that?**

I think it was in addition to it because again I really focused on, because there wasn't a drive to get the right answer and there was so much more discussion and everyone's point is valid, which it is in normal sort of instruction lessons but because you know where you're going to you tend to cut the kids short if you know where they're going is off on a tangent and you know you've only got 5 minutes. And I think with the CASE I always felt like I picked, it was a chance to give everyone a go, make everyone get involved as well, and when they're doing their group works go round and talk to them as a group. So that's how I felt it before.

**Do you think the students see you, and obviously they've got used to me as well, very differently to how, like if you had to sum up what maybe a couple of children think of the experience so far where there's these two teachers coming in and doing these lessons. What do you think would be their opinion of what's going on and how would they see both of us in a way?**

I think they must find it quite strange because any homework that they do get set is very much "go and talk to your parents about", "go and find out about". There's never been any written work. So I guess for some of them that maybe feel the pressure with written work subjects they probably think it's great and love it and think it's really good fun because they get to have a chat, they get to do experiments, they don't get any homework. But I don't know if maybe sometimes the more academic ones, sometimes might feel in danger of being a bit lost and sort of "how does this work?", "where does this fit in?". I don't think any of those particular students do, you never really see it on their faces but I think they could do depending on the kind of kids that were in the room. But I think they've got an idea of why they're doing it because we've both reinforced what the point of it is, it's brain training, it's to get you thinking better, it's to improve the way you work in groups. So I think because we've reinforced that so much, I think they kind of know where they're going and I think they'd probably be quite good at explaining it to their parents as to what goes on and why it happens like that.

**Ok thanks. Ok question 2: has your understanding of the pedagogy that underpins CASE developed since September? Obviously as you've said you've had quite an experience before. Has it been enhanced in any way?**

It's been nice to recap it but I don't feel like I've learnt more really. I think when we've had the sessions after school, because that's kind of, the level that you've been

**Comment [MSOffice7]:** MF(E)  
CASE allows all the students to have a chance to speak  
E: 6  
SoO: focus on students

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doing after school is kind of the level that we have it from King's on the PGCE and then obviously doing the MA it was specifically Vygotsky and Piaget but not actually CASE. So it was looking at them in more detail and so it's been quite nice bringing it back to CASE in that way and sort of seeing how it looks back on that level of a classroom Teacher C gain. So it's been nice to have the discussion and to have the recap but in terms of extending; I don't think it's extended my pedagogical understanding.

**Comment [MSOffice8]:** K&U  
Doesn't think it has been extended but it has been good to bring knowledge from CA back to the classroom (PM to M)  
K&U: 5

**So something that I've been made to think about in my knowledge and thoughts about Piaget especially is I've kind of excepted that his model is correct rather than it's a model and we're using it to help us understand cognitive development. Is that something you've explored in your Masters? Have they kind of introduced it as a particular model and there are others, or ...?**

Yeah, and we have Philip on a session about it so when we're talking about progression through the different stages and talking about the different reasoning patterns and is it possible for someone to be a 3A on one reasoning pattern and only be a 2A on a different one? And if Piaget's model is not possible you can maybe jump sort of a little bit above on individual reasoning patterns but you need to then bring it back. And we talked about in terms of you know, nodes on a graph, that they have to pass through those points before they can move on which did make me think "well hang on I don't think that is always the case" and so we did have quite a lengthy discussion that that is just a model. That works in a context. Which is quite a nice way anyway, I think as scientists we kind of accept that anyway about different theories and ideas; that this model works well for this situation but there's another model that would work equally well in a different situation. And so I think it fits quite nicely with the subject itself to think about it like that, as a model that happens to work in a situation.

**Comment [MSOffice9]:** K&U  
At quite an advanced stage based on her MA and considering the use of models  
K&U: 6

**Having attended the two sessions, so we've covered a bit of this question, having attended the two INSET sessions for the autumn term did you find anything particularly helpful at a pedagogical level as well as a practical one. So was there anything you kind of came away with and went "oh that is new to me" or "I'm going to try that out"?**

It was nice thinking about, you know, keeping the pace up because that was one of the things that we learned, you know bounding the questions out "you have a go, and now you" and that kind of, that way of doing things. And I maybe not, I let them have a lot more discussion I think normally and then get one person from each group to feed it back rather than trying to hit a lot of people in the group discussion. So that was one thing that I thought about doing slightly differently this year just to try it out and see. And in terms of the pedagogy like I said before, it was the opportunity to recap and think about it and bring it back to the CASE example rather than sort of the generic theories.

**Comment [MSOffice10]:** MF (C)  
INSET + PoC  
Useful in terms of pace and type of questioning (links to lesson obs) – reference to we learned  
C: 1  
PoC

**Have you used the Piagetian test data, well obviously I have seen it in operation in your group. So can you kind of expand on how you used that and how useful have you found that? Obviously I've been with you for some lessons but even when you're observing, you know, how have you found it useful?**

**Comment [MSOffice11]:** K&U + MF(C)  
INSET was a recap of pedagogy in relation to specific examples  
K&U: 7  
C: 2

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I think it was useful for putting them into groups and it was, I think that's one of the quite surprising bits of information, if I had them as a class Teacher and saw them more for more instruction content driven lessons, I think I would probably see a bigger difference than I do now. Because I knew their data before I really knew them. Whereas there are already girls who I think, I can't remember her name, sits near the front, is one of them. And she common sensically doesn't come across very right, very able and yet actually she comes up with very good ideas and with the CASE pre-test she came out with a very high level. And so I think it would maybe be more useful if I was there classroom teacher in a way because I'd already have the preconceptions about them by being their normal teacher, having that would make me re-think how I was going to group them and what I'm expecting from those students. And I think this Year it's almost slightly artificial in that sense; that I knew them through their data because I only see them once a fortnight. By the time I came to my next lesson with them after the test we have their data back and so I already knew who I was watching out for. And I think ordinarily, last year it surprised me who got which sort of levels on that pre-test.

**Comment [MSOffice12]:** MF( E)  
Has used the pre-test scores for grouping  
E: 7

**Do you think, sort of an extension of that, when often, when they're in the lesson that I've taken with your class there was a lot of getting paired up, did you ever think anything about watching the pairs? Did you think "oh that's obviously the one with the higher Piagetian level because of the way they're explaining"? Did that ever seem apparent?**

I don't think it's stood out in that sense, of the actual within the pairs. And I was quite careful to do as you said and keep them only maybe one sort of level apart anyway. And so I think once they've constructed it together and had that social construction activity the two of them I think even though during the activity one might be leading them more than the other; by the time they're confident enough to put their hands up they probably both feel as confident about it. I think it would be more interesting to see the difference in the pairs that don't maybe put their hands up; where it's just one of them that's got it and the other one still is lagging behind. I think it might be more obvious in that context than the ones who are confident enough to come up.

**Comment [MSOffice13]:** Relevant for discussion - only teaching this class CASE

**Yeah, that's interesting. Are there any practical tips or suggestions you would like to share with other colleagues about CASE lessons that you haven't had a chance to so far? Is there anything you feel you think works or particular activities?**

I think highlighting the fact that the data collection is really pretty insignificant. As long as you've got the data and they understand how it was gathered they don't necessarily need to have done it. And I know there are some lessons where it's really quite onerous; coin flipping. And when you've got a badly behaved group, like I did in a previous school, that was just a nightmare. And so I didn't do it like that and they only did 5 throws each and then I made up the rest of the data because I knew that was somewhere they could really go off task. And I think that's a, I think I've got the confidence to know I can cut it out because I know why I'm doing it and the purpose of doing different aspects of the lesson. I think people who are new to it very much, like, see the CASE booklet now as a recipe almost – I do this and I do that and I do

**Comment [MSOffice14]:** K&U + E  
Applies methodology to SRT data to the classroom  
Same as above

**Comment [MSOffice15]:** K&U +MF( E)  
Has the knowledge of the methodology to know the data collection part can be reduced  
K&U: 8  
E: 8

**Comment [MSOffice16]:** A&B  
Has the confidence now to adapt  
A&B: 1

## Appendix 4c: Transcript and Analysis of Interview I of Teacher C

that. And I think that's one thing is to re-enforce people that you don't need to do it if you think it's going to waste time, cause problems. And then there are other activities that I just think whilst nice activities on paper don't work brilliantly. The woodlice one is a real pain because we never seem to have enough woodlice, getting the woodlice into the choice chambers takes ages and the kids haven't got anything to be doing because you've already had your whole group discussions and there's not actually very much that they can be thinking about while you go around the room with one pot of woodlice distributing them between 6 different choice chambers and trying to get a good enough number in so you maybe end up with only 3 in each choice chamber and the kids have already pointed out "well that's not a lot of data is it Miss?" because they're so far down the CASE route. So there are lessons like that that in essence it would be a good activity and yet the mechanics of it sometime get in the way of what it is that you're trying to discuss and you end up fudging the results because the activity was never really going to work brilliantly in the first place.

**Comment [MSOffice17]:** MF(E)  
People who are new to CASE use it like a booklet  
E: 9

**So would you say there are particular activities from now your experience that you could suggest to colleagues "I think maybe that's even just a demonstration" or "that's", you know we have one that we will look at as a class...**

**Comment [MSOffice18]:** MF(E)  
Can adapt lesson especially when the practical aspects are problematic  
E: 10

Yeah, there are definitely one or two...

**already mentioned the chogs one, the equipment's hindering and you know. So to sum up are you saying one of the maTeacher Cr things that you think really has to be re-enforced to staff is that number crunching element and then where the equipment, you know, doesn't allow you to fulfil what you want to do and suddenly you're not doing any cognitive activity ....**

And the woodlouse one is a pain because you do actually need them all to have done it so you've got a big enough data group so that you can then sort of make sense of it. So that's always one of those one's that you have to kind of live with. If you're going to do it then you've got to do it the way it needs to be done and it's just a pain. But there are other ones like the pressure toadstools, it's just the manipulation of the equipment, the kids cannot hold it so they're not pushing it so it's just balancing and they'll put the mass on it to stop it wobbling over. And that's one where they don't need to have a huge set of data so that could very easily be done as 'let's all gather round, let's do it together' because just the manipulation of it and understanding of what it is they've got to do stops them from doing what's actually a really simple data collecting activity.

**Comment [MSOffice19]:** MF(E)  
Same as above

**Yeah, I don't think I've ever done the woodlouse one actually because I don't think we've had them. So I think it's probably, of all the activities, the one I've not done interestingly. So great, that's really helpful. Do you think the training programme specifically has, is altering your approach to normal instruction based lessons at the moment? Do you think because you're focusing on this quite a lot, do you think that's altering what you're doing in other lessons?**

I think it's always good to, when you recap a bit of pedagogy or a particular practice in the classroom, you can't help but let it influence what else is going on even if it's not with that group. Because obviously I don't see Year 7 for anything other than

**Comment [MSOffice20]:** K&U + A&B  
Good to have a recap on pedagogy; it can't help but influence you  
K&U 9  
A&B: 2



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CASE but with my Year 8s and my Year 9s having that reminder of what you're doing and why you're doing it, you can't help but use it when you're, sort of, going into your next lesson, you're planning your next lesson for the next week. And that's one of the good things about having it every half term, is it sort of keeps you being reminded of the little things and so... I just find myself whenever I go on any type of training, you just start to think of examples of it which is why training is done at the end of the Year or in the evenings, times when you're not going to be just about to plan a lesson, sometimes isn't the best time to have it. Because you've lost the enthusiasm and the motivation by the time you next come to do some planning. So having it dotted right throughout the Year I think does help. But I kind of feel sometimes I know what I should be doing and then it's the time that becomes an issue rather than my ability to include particular aspects in a lesson. Like creating cognitive conflicts; I know that helps children get engaged if it's an interesting enough example and if they feel they can get it, they get motivated, which is maybe some of the things on the CASE video about motivation. I was thinking about that. If they feel like they've got the cognitive conflict and can resolve it, which in some of the early Year 7 lessons they can actually resolve it quite easily. I think maybe that's where the motivation comes from to do with CASE, is feeling that you've achieved. Because it was hard and yet you still managed to do it. Which I don't think the CASE maybe with the later lessons, because they're still going out with that cognitive conflict and sometimes they feel like they've never solved it. And so it is nice to bring that aspect into lessons and also bring in construction activities. And I know, I did a project on particles trying to use constructivist ideas so that they're the ones constructing and understanding from a range of phenomena. So all these ideas and theories I try to include but then sometimes just through time pressures and what needs to be done and when it needs to be done, it's not always possible to include it. But I wouldn't say anything's drastically changed as a result of this term. But then it's probably because I already am quite confident and aware of what's going on anyway behind the....

**Great, is there any particular area you would like more support with or development with ideas with? Like I suppose I'm sort of building on where I would, you know coaching here essentially. Is there anything that you think "I would like more; Martina to focus on with me particularly" or "I'm interested in this"? Is there anything that springs to mind?**

I think it would be quite nice as a department to come up with more CASE style activities to fit into other lessons. Which I know was the original sort of idea with Philip and Michael was that this is a way of getting people to understand this methodology and the point of it but, and you know with the 'thinking through science' books it was kind of the idea that it would eventually become a much bigger part of mainstream teaching. And sometimes you can think of a great example and then you forget it or you don't share it with somebody and then it kind of gets lost again and I think that would be nice, if as a department we spent a little bit of time trying to think "right lets think of a Year 7 topic where we could use a bit of that methodology or a Year 8 topic" and I think that would be really nice, taking that and using it elsewhere and building upon it. Because it feels like we do it and it gets done and it's done well and then it kind of never really develops into something more. And I think that would be nice if it could. (20.44)

**Comment [MSOffice21]:** INSET C  
Having it once every half term is good  
C:3

**Comment [MSOffice22]:** E  
Feels she knows what she should be doing  
and has the ability but it's the time  
E: 11  
SoO: time an issue

**Comment [MSOffice23]:** K&U +E  
References to CASE methodology and  
students' motivation if they can resolve the  
conflict  
E: 12  
K&U: 10

**Comment [MSOffice24]:** SoO  
Invention of lessons using construction  
activities

**Comment [MSOffice25]:** MF(E)  
Time is a constraint  
E: 13

**Comment [MSOffice26]:** A&B  
Nothing has changed too much because she  
is already quite confident  
A&B: 3

**Comment [MSOffice27]:**  
SoO: Invention

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**Building on this a question that springs to mind is obviously there has been key stage 3 work that like Caroline Yates and Christine Harrison wrote I remember Wigan group interesting stuff with key stage 4. do you think there's more benefit using something that other people have done or do you think it's more useful people devising the lessons themselves because that way they're more likely to then apply the approach to other lessons? You know if you've had to come up with creating a lesson.**

I think it really depends on what's available and why it was written. Because sometimes things are written to try to suit too many things so actually it suits nobody, in the end, well. But I know that the 'thinking through science' books that Chris Harrison does, I've looked through some of them and there's some amazing, really nice, brilliant activities in there and then there's other activities where I read it and I don't really understand the point of it. And so I think maybe it's the level of guidance that's important because the CASE project, if the folder had just been created and thrown into schools and 'off you go with it' I really don't think it would have taken off. I think it's all the support that came through King's originally to get that in place, to train teachers to do it, to train trainers to go into other schools to do it, made it do so well. And I think if people think that you can just write a book and go "there you go", it's not going to do as well because people, you can read something and it not make sense and unless you've got somebody to go back to and say "what's the point of this, what aim are you getting at here?" I think that's the danger with poor resources. If you don't understand the point of it you follow the rules and, like I was saying with the CASE instructions, you follow it like a recipe and you might get bogged down in something that's actually not very important because the guidance isn't really brilliantly clear and you haven't got the opportunity to ask questions. Then it's wasting a load of time on something that's actually not that productive. Whereas the advantage of making your own is you know what the purpose is when you go and do it. At least you know the thrust of the lesson and what it is you're trying to get at.

**So I mean I think that asks another important question or interesting question: why can't people pick up the CASE folder and just get on with it?**

I think for some of the lessons there's so many things going on and there's so many concepts to get your head around which if you're coming to it completely fresh without understanding what the point is, because I think you know the social construction idea of Vygotsky is probably quite a simple one, people can grasp that, it's kind of common sense in a way of on a very simple level people working together can get more done than people working on their own, because they can have that discussion to build ideas. I think that kind of aspect of it people get, people understand that. But I think sometimes the equipment in there maybe and the context that it's set in, if it's a context that people aren't familiar with. So they're then busy struggling with the context then they can't get out of it what they're trying to get out of it. So if there's people who don't understand pressure or don't understand a science concept that's being used to develop a reasoning pattern then they get bogged down on what should really be the preparation for the students, the teacher could get bogged down in it and then it doesn't really go to where it could be going to.

**Comment [MSOffice28]:** PoC  
Need support and guidance

**Comment [MSOffice29]:** K&U + MF(E)  
Relates lack of understanding to why the teachers would follow the instructions like a recipe  
E: 14  
K&U: 11

**Comment [MSOffice30]:**  
SoO: Invention  
If you devise it you know the purpose

**Comment [MSOffice31]:** MF(E) + K&U  
So many aspects to a CASE lesson and concepts and without knowledge – implies this is needed  
K&U: 12  
E: 15

**Comment [MSOffice32]:** K&U  
Specific example of social mediation being straightforward  
K&U: 13

**Comment [MSOffice33]:** E + K&U  
People might struggle with context and equipment  
Same as above

**Comment [MSOffice34]:** K&U & E  
Implies that lack of knowledge and understanding of concepts /reasoning patterns would affect practice  
Same as above but specific about knowledge



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**It's really interesting isn't it that whole area...? Do you use your, 8<sup>th</sup> question is do you use your Teacher Journal and have you found it useful? So kind of is it something you think is a useful thing to do; to write down reflections?**

I've used it after lesson 2 I think it was, anyway a lesson I did that you came to watch me on. And so I think that was going to be quite useful because I made notes there and then so that when we came to have a discussion and you'd made notes, it was quite helpful to have something to look back to remember the order of events happening. I think if it was just for me (loud noise) the feel of how it went, I don't know because I think it could be useful in terms of 'what way did that happen'. Because if you remember something amazing happening and you can't remember the thing that led to it happening then you can't help recreate it. But then at the same time I'm a bit, you know it's finding the time to sit and write it. And if it's period 4 and you've left it until the end of the day already some of it's gone out of my head after teaching another double lesson. And so I think the reality of it means it doesn't work brilliantly. But I think it could work very well, I think it would be very helpful to just sit down and do, spend 10 minutes.

**Comment [MSOffice35]:** PoC Journal  
Used it once to notes in a sense to prepare for our discussion  
PoC: 1

**Comment [MSOffice36]:** Journal PoC  
Recognises the value but acknowledges time constraint  
PoC :2

**Are there any things you find difficult with CASE, that you find uncomfortable, that you find you walk out thinking "I'm not sure if that was a good lesson"? Is there anything on that negative level?**

I think sometimes with really academic students, not necessarily bright but academic in terms of wanting to achieve, wanting to have something written in their books, wanting to go away knowing something new, sometimes it can be a bit disheartening if they can't grasp why it is you're doing the lessons and they go away with that conflict still unresolved. And they're unhappy about it and making it quite clear that they're unhappy about it and sometimes you know that can bring down the mood with the group and my mood if I feel that that's the way the lessons ending; with something unresolved and they don't like it and they feel unhappy about it. So I think that's one negative and another thing it's just the equipment. I think sometimes that is so much hassle making sure everything's set up, making sure... because it's fiddly experiments they're doing with the pulleys and the springs. There's some really quite fiddly equipment retort stands, which for Year 7s is something completely that they've never used before. And you can feel like you run around the room setting up equipment because there's been a group in there the lesson before so it couldn't be set up in advance. And those kind of things sometimes can get you down because you feel like you're just wasting your time, you're not actually asking them any questions while you're running around, you're not checking their understanding, you're just setting up equipment and sort of the potential, you're not going to reach the potential of what you could get to sometimes because you're just wasting your time doing that kind of activity instead.

**Comment [MSOffice37]:** SoO  
Focuses on the students in terms of bright students and learning

**Comment [MSOffice38]:** E  
Practical side in terms of equipment can be a negative  
E: 16  
SoO: does still mention technical side

**Is there anything else you would like to mention about any of this programme that you haven't had a chance to so far?**

I don't think so

## Appendix 4c: Transcript and Analysis of Interview I of Teacher C

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**Ok thanks very much for your time, sorry to have kept you waiting and that's been really helpful**

## Appendix 4d(i): Questions for Semi Structured Interview I – Autumn Term 2007

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1. How would you compare your preparation for CASE lessons to other Science lessons?

General

2. How has your understanding of the pedagogy that underpins CASE developed since September?

Question 1 Knowledge & understanding

3. Having attended the two INSET sessions of the Autumn Term, what have you found particularly helpful on a pedagogical level as well as a practical one?

Question 1 Knowledge & understanding

Question 2 Experimentation

4. Have you found the Piagetian test data useful? How have you used this information in lessons?

General

5. Are there any practical tips or suggestions you would like to share with other colleagues – both general and specific – about CASE lessons?

Question 2 Experimentation

6. Do you think the training programme is altering your approach to normal instruction- based lessons?

Question 2 Experimentation

7. Is there any particular area you would like more support with?

General

8. Do you use the journal? Have you found this helpful?

Question 2 Process of change

9. Are there any things you find difficult when teaching CASE lessons?

Question 1 Attitude & beliefs, Nature of the Change Process

Question 2 Process of change

10. Is there anything else you would like to mention that has not been addressed through this interview?

General

## Appendix 4d(ii): Questions for Semi Structured Interview II – Spring Term 2008

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Questions 1 and 2 – I intend to probe the role of the trainer; I am interested in what gives a trainer the necessary authority/knowledge to train other staff; I think this is extremely pertinent to the current situation with respect to the longevity of CASE in schools.

1. I would like to explore the role of the trainer in the PD of teachers particularly what qualities /experience do you think a trainer needs to have to give him/her the necessary status to coach/mentor other teachers? I realise this may be difficult to answer due to my multiple roles but the answer can be a general one or relate to specific examples where you have been trained/mentored by someone.

General

2. Do you think there are any advantages and disadvantages to a school based trainer as opposed to an outside consultant?

General

Questions 3, 5 and 5 are focused on the INSET sessions and maintenance of CASE in schools

3. How do you think INSET sessions can be best used to keep the project alive in schools, considering factors such as staff turnover etc?

Question 2 Collaboration

4. How useful have you found the sessions since our last interview? Have you acted upon anything specific?

Question 2 Collaboration, Experimentation

5. If a school was trying to maintain the CASE project, what advice would you give them especially if there isn't a trainer and therefore the teachers need to keep the approach alive themselves?

General

Questions 6, 7 and 8 are focused on the Teachers' PD

6. Do you think there are any specific things, with respect to the development of teachers, which cause a conflict or hinder development? Again your answer could be very general or specific.

Question 1 Attitude & beliefs, Nature of the change process

## Appendix 4d(ii): Questions for Semi Structured Interview II – Spring Term 2008

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### Question 2 Process of change

7. Through INSET we discussed the role of the teacher and looked at some video evidence at the last INSET session. What is your opinion on the teacher in terms of giving information and showing affirmation during class or small group discussion?

### Question 1 Attitude & beliefs

8. Are there any specific examples this year where you taught a Science lesson using the CASE approach?

### Question 2 Experimentation

## Appendix 4d(iii): Questions for Semi Structured Interview III– Summer Term 2008

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1. Looking at the questionnaire you completed at the beginning of the year, I would like to ask ..(this will depend on how they answered their questionnaire – I will also clarify details that I will need for their biographies).

### General

2. How do you think you have developed as a CASE teacher this academic year in terms of your delivery of a CASE lesson and your understanding of the theory that underpins the CASE approach?

### Question 1 Knowledge and understanding, Nature of the change process

### Question 2 Experimentation,

3. Do you think you have changed your opinion/view on the nature of learning?

### Question 1 Attitude & beliefs

4. Can you identify any positive and/or negative aspects about the work we have been doing together this academic year?

### Question 1 Attitude & beliefs, Nature of the change process

### Question 2 Process of change

5. In terms of the lesson observation, how useful/important was my demonstration lesson?

### Question 2 Modelling

6. In what ways do you think you have been affected by my multiple roles as trainer, researcher and Deputy Head?

### Possible bias to research

7. Do you now feel confident to plan and deliver any CASE lesson? Has that changed over the year?

### Question 1 Attitude & beliefs

8. Would you feel comfortable being observed delivering a CASE lesson by visitors to the school?

### Question 1 Attitude & beliefs

## Appendix 4d(iii): Questions for Semi Structured Interview III– Summer Term 2008

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9. Have you found the lesson observation form helpful in terms of the time spent on different cognitive activities and the strengths and recommendations? In what ways could it have been improved?

### Question 2 Lesson Observation & feedback

10. How useful have you found the feedback part by colleagues at the beginning of the INSET sessions?

### Question 2 Collaboration

11. Do you think collegiality is an essential part of professional development with the CASE project?

### Question 2 Collaboration

12. Do you think your intuitive knowledge has changed in terms of how you interact with students during the discussion part of CASE lessons?

### Question 1 Knowledge

### Question 2 Experimentation

13. In what ways do you think CPD needed for teaching CASE is different to other CPD such as the introduction of the new KS 3 and 5 curricula?

### Question 1 Nature of the change process

### Question 2 Process of change

Appendix 4e: Identified themes from semi-structured interviews in relation to research constructs

Construct	Theme 1	Theme 2	Theme 3	Teachers
Knowledge & Understanding (K&U)	Theory & Practice	Progression of knowledge, including psychological models and CASE methodology	Application of knowledge	Parity among teachers
Attitude & Beliefs (A&B)	Confidence	View on learning	Personal difficulties	Parity among teachers
Experimentation (E)	Progression and use of approach	Specific methodological aspects in relation to the roles of the teacher and students		Parity among teachers
Collaboration (C)	Usefulness including the approach used			Parity among teachers
Lesson Observation and Feedback (O)	Importance	Measurement of progress	Structure and type of advice	Teacher A – all three Teachers B&C – theme 3 only
Modelling (M)	Modelling the methodology	Usefulness /Importance		Teachers A& B – both Teacher C – theme 1 only
Process of Change (PoC)	The process of learning	How it was brought about, especially in relation to the mediating factors	Teacher A - recommendation about the process Teacher B -confidence in students	Teacher A & B – theme 1 <sup>st</sup> & 2 <sup>nd</sup> the same, 3 <sup>rd</sup> different Teacher C – very little evidence



#### Appendix 4f: Distribution of participant teachers' responses

##### Teacher A

<b>Construct</b>	<b>Interview 1</b>	<b>Interview 2</b>	<b>Interview 3</b>	<b>Total</b>
<b>Knowledge &amp; Understanding (K&amp;U)</b>	1-6	7-9	10-12	12
<b>Attitude &amp; Beliefs (A&amp;B)</b>	1-3	4-5	6-9	9
<b>Experimentation (E)</b>	1-8	9-12	13	13
<b>Collaboration (C)</b>	1-3	4-5	6-8	8
<b>Lesson Observation and Feedback (O)</b>	1-5	6-9	10-17	17
<b>Modelling (M)</b>	1-7	8-12	13-15	15
<b>Process of Change (PoC)</b>	1-8	9-12	13-19	19

##### Teacher B

<b>Construct</b>	<b>Interview 1</b>	<b>Interview 2</b>	<b>Interview 3</b>	<b>Total</b>
<b>Knowledge &amp; Understanding (K&amp;U)</b>	1-7	8-9	10-15	15
<b>Attitude &amp; Beliefs (A&amp;B)</b>	1-9	10-11	12-19	19
<b>Experimentation (E)</b>	1-18	19-24	25-31	31
<b>Collaboration (C)</b>	0	1-3	4-9	9

#### Appendix 4f: Distribution of participant teachers' responses

<b>Lesson Observation and Feedback (O)</b>	0	1	2-3	3
<b>Modelling (M)</b>	1-4	5-6	7-12	12
<b>Process of Change (PoC)</b>	1-10	11-14	15-19	19

#### Teacher C

<b>Construct</b>	<b>Interview 1</b>	<b>Interview 2</b>	<b>Interview 3</b>	<b>Total</b>
<b>Knowledge &amp; Understanding (K&amp;U)</b>	1-13	14-16	17-18	18
<b>Attitude &amp; Beliefs (A&amp;B)</b>	1-3	4-5	5-6	6
<b>Experimentation (E)</b>	1-16	17-23	24-26	26
<b>Collaboration (C)</b>	1-3	4-6	7-9	9
<b>Lesson Observation and Feedback (O)</b>	0	0	1	1
<b>Modelling (M)</b>	0	1	2-3	3
<b>Process of Change (PoC)</b>	1-2	3	0	3

## Appendix 5a: Science Reasoning Test Report – September 2007, Pre-Test SRT II – Volume & Heaviness

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### Report on Year Seven at School

October, 20, 2007

#### Commissioned by:

Martina Lecky

Your year 7 pupils were tested with the Piagetian Reasoning test, Task II, Volume and Heaviness during Autumn term 2007. The tasks were marked and entered by you and analysed by me. The statistics and graphical results are shown below.

#### Technical details are in Appendix 1 at the end of this report

Volume and Heaviness is a criterion reference test developed in 1976. Recent Research (RES-000-22-1379, “Have the Norms for Volume and Heaviness for Year 7 changed since the mid 1970s “ carried out by Michael Shayer for the ESRC) has shown that there has been an absolute drop of 22%le points of Year 7 by 2004 compared to their position in 1976. The boy girl differential which was expected has gradually disappeared

**The analysis of this report is based 2003 data;** the Piagetian levels are still accurate, and have proved good predictors of Science performance since understanding of conservations is such a basic science concept.

#### Summary Statistics

<b>Number of pupils in cohort</b>	<b>154</b>
<b>Number taking the test</b>	<b>154</b>
<b>Number scoring 1 or more on test</b>	<b>154</b>
<b>Mean age</b>	<b>11 years 6 months (estimated)</b>
<b>Mean level</b>	<b>4.75</b>
<b>Mean percentile</b>	<b>63.9 (40.4)</b>
<b>Median percentile</b>	<b>58.9</b>

Figure in brackets refer to 1976 norms that you will have seen in previous reports

### Test administration:

Figure 4 shows the proportion of your pupils passing each item, compared to a reference line. Although the pupils should not get the same proportion of each item correct as the reference school, the overall pattern should be similar. This gives a check on the test administration.

The class profiles are consistent with the reference line, but there are some difficulties. When the pupils with two or more formal items correct are studied, 8 do not succeed on item 10 (conservation of volume, and may have 3a, 6 7 or 8 incorrect. This suggests that they have been overmarked on item 12 and 13b, and that the mean percentile for this cohort is a slight overestimate. Girls scoring at Concrete Generalisation have always shown in the top 5%le for the test, so this group of 14 pupils shown in blue in the accompanying data table, are well estimated.

4 pupils in H, T and Y have only one item correct, score at lower than 5%le on the test, and are shown in red.

Table 1 shows the National percentage of pupils at each Piagetian level, observed during the CSMS survey. Your pupils are shown by the side of this. This information is presented graphically in figure 1 as two side by side boxplots. 58% of the pupils score in the top half of the national distribution for this test. The top outliers, are three students whose names have been omitted. .

**Table 1**

CSMS survey National Average interpolated for 11 years 7 months.			Year 7 in 2007	
Level	%	cum. %	%	cum. %
3A	2.5	2.5	3.9	3.9
2B*	6.8	9.3	14.3	18.2
2B	19.5	28.8	27.9	46.1
2A/2B	32.7	61.5	22.1	68.2
2A	24.8	86.3	24.0	92.2
<2A	13.7	100.0	7.8	100.0

Figure 2 shows the Piagetian levels of your entire year 7 as a histogram. Here the major mode of 35 pupils is at level 5 to 5.5, above the national median of 4.4 for girls of this age. Note secondary mode of 22 pupils at level 3.5.

Simple class statistics are shown in figure 3 and table 2.

**Table 2**

	All	7C	7G	7H	7R	7T	7Y
number	154	25	25	25	26	27	26
mean level	4.75	4.40	5.8	4.34	4.63	4.8	4.52
mean percentile	63.9	52.0	88.7	49.8	59.9	65.9	56.0

There seems to have been some streaming between the classes, since class 7G has no low scoring pupils. This has not prevented two high scoring girls in 7R, two students whose names have been omitted who have sufficiently different Piagetian levels from their peers to possibly have communication difficulties in this class. The class ranges in T and Y are also broad so their may be difficulty for pupils at the extremes of the range in these classes.

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## Technical Terms

### 1. The Piagetian scale

Name	Short form	Numerical
Formal Generalisation	3B	$\geq 9$
Mature Formal	3A/3B	8
Early Formal	3A	7
Concrete Generalisation	2B*	6
Mature Concrete	2B	5
Mid Concrete	2A/2B	4
Early concrete	2A	3
Pre-operational	1A-1B	1-2

### 2. Types of statistic

The statistics in your report are of two types. Mean level and Mean percentile have to be calculated from those pupils who had 1 item or more correct on the test. However schools with very low entries have some pupils who are unable to score at all. We have included all these pupils when we look at Histograms and Boxplots, and when median, or quartiles (non-parametric statistics) are reported.

**Histogram:-** The histogram shows the distribution of Piagetian level in your cohort. Each bar represents the number of pupils at a particular Piagetian level. We use a standard presentation of half level steps, so that you can see the distribution of pupils within each Piagetian level.

**Boxplots:-** The boxplot is the best way of comparing the overall distribution of levels of your pupils with other comparable data. The central rectangular plot contains the middle fifty percent of your pupils. The line within this is the median, the Piagetian level of the pupil who, when the marks of each student are arranged in ranking order occupies the middle position. The two vertical bars (whiskers) above and below the central box extend across the main body of pupil scores; those pupils whose scores are extreme outliers are shown as individual points (small circles)

**Percentiles:-** Conversion of data to percentiles involves mapping ranges of data onto a linear scale from 0 to 100. This is best explained by example. If there are 5400 secondary schools in the country and a school is 63rd from the top in its GCSE statistics then its percentile ranking is 98.8 calculated as below:-

$$[ 100 * (5400 + (1 - 63)) / 5400 ]$$

In the CSMS survey (OHT 2.1 in the INSET pack, and fig. 4 in this report) we provide curves which show Piagetian levels of pupils at the 95th, 90th, 75th, 50th, 25th, 10th, and 5th percentiles of the population from age 6 to 19. At any particular age one can draw a vertical line through the graph and its intersection with the percentile curves gives the Piagetian level of that percentile of pupils; e.g. at age 11<sup>1/4</sup> 50% of all pupils will have a Piagetian level of 2B or below.

This makes a convenient background for the boxplot of your school data, for you can compare the 25%ile, 50%ile and 75%ile of your school at 11 years 7 months with the national data at this age. **Note that since there is no boy girl differential on this test at the present, the girls' levels have not been readjusted in this figure.**

## Appendix 5b: Science Reasoning Test Report – September 2008, Post-Test SRT II – Volume & Heaviness

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### **Report on Post test on beginning year 8 at name of school omitted, 2008**

**Commissioned by:**

**12-Dec-08**

Martina Lecky

Your year 7 pupils were tested with the Piagetian Reasoning test, Task II, Volume and Heaviness during September 2007 and post- tested in Autumn 2008 with Task II again. The tasks were marked and entered by you and analysed by me. The statistics and graphical results are shown below.

**Technical terms are explained in Appendix 1 at the end of this report**

### **Summary Statistics (Name omitted School)**

<b>Number of pupils in cohort</b>	<b>156</b>
<b>Number taking the test</b>	<b>154</b>
<b>Number scoring 1 or more on test</b>	<b>153</b>
<b>Mean age</b>	<b>12 year 7 months</b>
<b>Mean level</b>	<b>5.18</b>
<b>Mean percentile</b>	<b>70.5</b>
<b>Median percentile</b>	<b>73.9</b>

## Appendix 5b: Science Reasoning Test Report – September 2008, Post-Test SRT II – Volume & Heaviness

### Test administration and analysis

Test performance in figure 1 satisfactorily follows the reference profile. Note that the classes 8C and 8R have underscored on item 14, and all of the classes have found 3B difficult, perhaps because they are making more complex models than the item warrants. This would reduce the mean percentile slightly (up to about 3%ile points).

3 pupils are shown as not scoring though named omitted and named omitted may not have been present for the test, leaving only in named omitted 8T as the only non-scorer. 9 pupils show some form of formal thinking with 23 % scoring above the 75%ile.

Table 1 and Figure 2 shows the National percentage of pupils at each Piagetian level, observed during the CSMS survey. Your pupils are shown by the side of this. Note here that the interquartile range has been very suppressed with nearly three quarters of the pupils in the top half of the national distribution; 60% show at the mature concrete level or above, and twice as many are showing Concrete Generalisation.

**Table 1**

CSMS survey National Average girls interpolated for 12years 5 months.			Year 9 in 2002	
Level	%	cum. %	%	cum. %
3A	3.36	3.36	4.5	4.5
2B*	8.54	11.90	18.2	22.7
2B	22.52	34.41	36.4	59.1
2A/2B	32.68	67.09	20.8	79.9
2A	21.70	88.79	15.6	95.5
<2A	11.21	100.00	4.5	100.0

The histogram of this cohort is surprisingly normal in shape (figure 3 right) compared to the beginning of the year. The shoulder of pupils below level 4 has disappeared, most of the development seems to be in the concrete region.



## Appendix 5b: Science Reasoning Test Report – September 2008, Post-Test SRT II – Volume & Heaviness

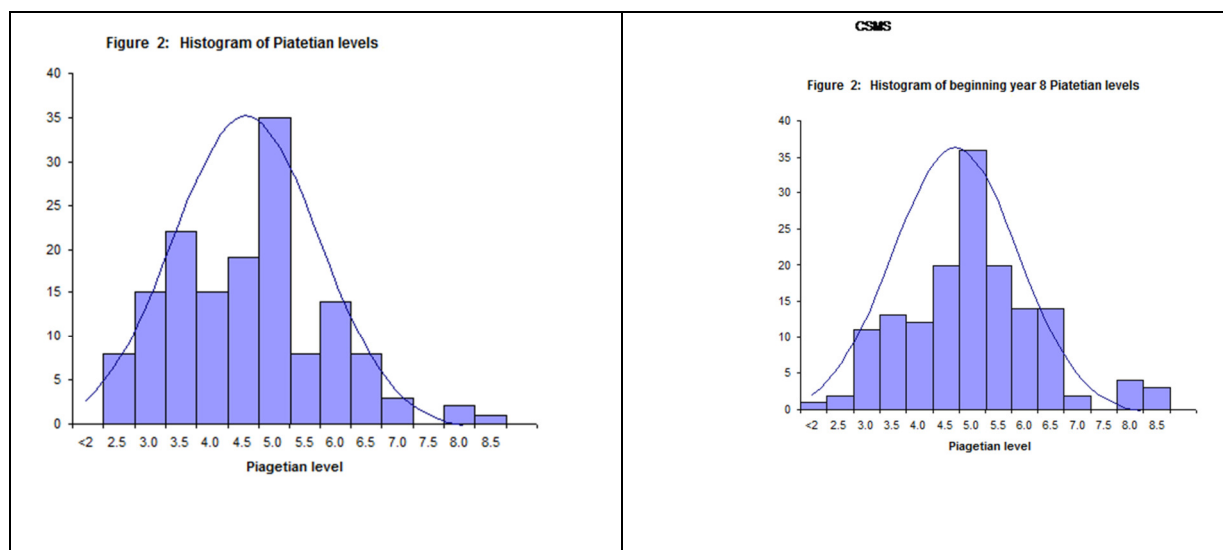


Figure 3: Histograms of the cohort at the beginning (left) and end (right) of year 7

Simple class statistics are shown in table 2 and represented graphically in figure 4.

**Table 2**

	All	7C	7G	7H	7R	7T	7Y
number	154	27	27	24	26	25	24
mean level	6.14	5.00	5.97	4.89	4.7	5.1	5.39
mean percentile	70.5	65.2	87.6	61.7	55.5	68.1	76.0

There are wide ranges within the forms with for example in class 8T students presenting with Early Concrete and Mature formal scores in the same class. 8G has no pupils below the mid concrete level. All class now have pupils at least at the Concrete Generalisation level.

## Appendix 5b: Science Reasoning Test Report – September 2008, Post-Test SRT II – Volume & Heaviness

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### Pre-post test comparison:

149 pupils, nearly the entire initial cohort were present for both tests.

Only pupils present and scoring on both tests were analysed. Table 3. shows the difference in mean percentile of all the pupils in this category.

**Table 3**

	pre	post	Difference
Number	149	149	
Mean level	4.75	5.14	
Mean percentile	63.8	69.5	5.7

This increase in mean percentile is not significant.

The scatter plot figure 5 of pre-post test scores is as expected, because you would always expect some regression to the mean on post test, that is children at the extremes would be likely to have a test score nearer to the mean level on post test. However there are some extreme cases of this in this cohort. On the scatter plot the dotted line shows the one to one relationship, and the regression line reflects the regression to the mean effect. Named omitted and named omitted present a conundrum since although they scored so well at pre test on formal items, they have performed fairly badly at post test, suggesting some social problems with these girls.

Where have effects occurred. The CASE system tries to reinforce development of formal thought, so the number of formal items was compared. On the 1973 scoring rules pupils were considered formal thinkers if they had two or more formal items correct

**Table 4**

no of formal items correct	pre-test	post test
1	35	32
2	15	6
3	3	4
Total	53	42

On pre test 18 pupils are in the formal category compared to 10 at post test

## Appendix 5b: Science Reasoning Test Report – September 2008, Post-Test SRT II – Volume & Heaviness

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### Class details

The data was compared by Year 7 group and results shown in table 6 and figure 6.

**Table 6**

Class	Mean percentile pre test	Mean percentile post test	Difference	Effect size
7C	52.0	64.5	12.4	0.32
7G	88.6	88.0	-0.7	-0.04
7H	49.8	66.8	17.0	0.41
7R	59.9	53.7	-6.2	-0.17
7T	65.9	66.9	1.0	0.03
7Y	56.1	71.0	14.9	0.36

None of the effect sizes are significant, we would usually look for an effect of more than half a standard deviation. Class R has the lowest movement, with a mean increase only of 0.02 Piagetian levels.

### Discussion

Overall there has been no mean developmental increase for this cohort after the first year of CASE lessons; in fact testing over the years has seldom shown an increase after the first year. The development of formal thinking in the girls needs to be consolidated and exposure to formal ideas in all curricula will contribute to the stabilisation of formal thinking at the neuronal level. The modern school curriculum does not encourage this; since most exposure especially in Science and Mathematics but also in Arts subjects in years 7 to 9 seems to be increasingly at the Concrete level. This is no doubt the contributor to the loss of that shoulder of pre-concrete pupils seen in figure 3, and the increases of pupils at the Concrete Generalisation stage. Indeed possession of Concrete Generalisation thinking ability will allow pupils to obtain reasonable marks (Grade C and above) at GCSE in Science. For the higher level thinking pupils increase in exposure to Formal ideas in Science and Mathematics will now help to maintain Formal thinking, and to develop it in pupils at the higher end of the Concrete Generalisation range.

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[Appendix 5c: Science Reasoning Test Report – September 2009, Post-  
Test SRT IV – Equilibrium in the Balance

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**Report on Post test year 9 class at name omitted, 2007-9**

**Commissioned by:**

**23 Jan 10**

Martina Lecky

A class of year 7 pupils were tested with the Piagetian Reasoning test, Task II, Volume and Heaviness during Autumn term 2007 and post- tested in Summer 2009 with Task IV Equilibrium in the Balance. The tasks were marked and entered by you and analysed by me. The statistics and graphical results are shown below.

**Technical terms are explained in Appendix 1 at the end of this report**

**Summary Statistics**

	Task IV
Number of pupils in cohort	152+
Number taking the test	152
Number scoring 1 or more on test	152
Mean age	14.3 est.
Mean level	6.29
Mean percentile	61.5
Median percentile	56.0

**Normalised to 1980**

## [Appendix 5c: Science Reasoning Test Report – September 2009, Post- Test SRT IV – Equilibrium in the Balance]

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### Test administration and analysis

Figure 1 shows the proportion of your pupils passing each item, compared to a reference line. Although the pupils should not get the same proportion of each item correct as the reference school, the overall pattern should be similar. There is good correspondence between classes and the reference line so that the test should give a good estimate of pupils' thinking ability.

8 pupils score 2 or more mature formal items correct, and 8 pupils show at the mature formal level using Rasch analysis. Although Andre de lima does succeed on two of the mature formal items, she has not given correct items for some less difficult items, and these two successes may be an anomaly.

Most pupils scoring above 95%ile are in class 9G. However three students names have been omitted in classes T and Y have also scored above this level. All of these students are shown in blue in the accompanying data table.

7 pupils had only one item correct.

Table 1 and Figure 2 shows the National percentage of pupils at each Piagetian level, observed during the CSMS survey c. 1976. Your pupils are shown by the side of this. The upper outliers are six students names have been omitted. The distribution is skewed to higher levels than the old National distribution with an increase of pupils showing Concrete Generalisation levels.

**Table 1**

		CSMS survey (1976) National Average girls interpolated for 14 years 4 months.		Year 9 in 2009	
Piagetian	Level	%	cum. %	%	cum. %
Mature formal or above	>=3A/3B	4.04	4.04	5.26	5.26
Early Formal	3A	12.98	17.03	9.87	15.13
Concrete Generalisation	2B*	32.96	49.98	45.39	60.53
Mature Concrete	2B	32.97	82.96	34.87	95.39
Mid Concrete	2A/2B	17.04	100.00	4.61	100.00

## [Appendix 5c: Science Reasoning Test Report – September 2009, Post-Test SRT IV – Equilibrium in the Balance]

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For further comparison year 9 pupils may be compared to the proportion of formal thinkers in the population as a whole sampled in 2007.

**Table II Whole cohort comparison with 2007 Formal operations paper**

Test type	Age	Mean level	proportion showing formal operations.
Equilibrium in the balance (2006)	13.3	5.72	5.0
The Pendulum (2007)	14.3	6.04	12.9
Your 2009 cohort	14.3	6.29	15.1

Compared to the population now your pupils show a much higher mean level than the pendulum test for year 9 pupils. Pendulum has a higher proportion of items that can be answered at the concrete generalisation level.

The histogram of figure 3 shows the distribution of girls in this cohort. This is positively skewed with a major mode of 43 pupils at Piagetian level 6 to 6.5.

### **Comparison between year groups:**

143 pupils from the initial cohort (%) were present for both tests. This is 93% of the initial cohort which is a very good sample.

Only pupils present and scoring on both tests were analysed.

### Calculation of percentile change of the mean.

Difference in Greycoat – Year 9 Task III = 0.25 Piagetian levels

**Table 3. Piagetian level means and standard deviations**

	Mean level	Standard deviation	Level difference/standard deviation	Z proportion of pupils below Piagetian level 6.29
Task IV mean level year 8	5.72	0.923	0.272	60.9
TaskIII mean level year 9	6.04	1.055	0.271	60.68
Greycoat year 9 Task IV	6.29	0.9197	0.237	59.1

There is no direct comparison between your cohort and the means worked out during the Formal operations exercise 2006-7. It is likely that Task IV mean Piagetian level at year 9 will be slightly less than task III Piagetian mean levels, because more of the TaskIII questions can be answered using Concrete Generalisation schemas for control of variables. But to be

## [Appendix 5c: Science Reasoning Test Report – September 2009, Post-Test SRT IV – Equilibrium in the Balance

conservative I have used the Task III means. This estimates the Mean percentile of your year 9 pupils to between 59.1 to 60.9 which is not a significant difference from the pre-test. This can be summarised in table 4

**Table 4**

	pre	post	Difference
Number	143	143	
Mean level	4.74	6.29	1.55
Mean percentile	63.8	60.7	-3.1

Because of the reasons above it is probable that task III overestimates the mean Piagetian level which would be attained national on Task IV at year 9. Table 5 shows the mean percentile of your cohort for different national means of task IV. Had the mean Piagetian level been as low as year 8 the effect size of your intervention would still be low.

**Table 5**

	starting national level	final percentile Greycoat cohort	Calculated effect size from this mean percentile
Task III year 9	6.04	60.68	0.08
	6	62.55	0.03
	5.89	66.6	-0.08
Task IV year 8	5.72	73.14	-0.27

It is unlikely that the Year 9 Task IV Mean percentile is as low as the mean level in year 8, so it is probable that there was no effect of intervention in this cohort.

### **% at formal thinking**

Shayer and Ginsburg 2009 showed that although the means of the Formal tests had not reduced significantly since the tests were developed, the proportion of pupils reaching formal thinking levels has declined markedly so that only 5% of the pupils in year 8 were showing formal thinking compared to about 20% in 1976. By year 9 in 2006 this proportion had nearly doubled on Task III; but is still half that of 1976. The comparison for the pre-post test is in table 6

[Appendix 5c: Science Reasoning Test Report – September 2009, Post-  
Test SRT IV – Equilibrium in the Balance

**Table 6 Percentage of pupils with formal thinking skills.**

task	pre	task	post	
	II	IV	taskIV	pendulum
age	11.7	13.3	14.3	14.3
national average	3.36	5	*	12.9
your school	4.2	*	<b>15.5</b>	*

**It is probable that this 15% is a significant increase but there is no direct evidence to support this at present**

### **Class comparisons**

Piagetian means pre and post test are shown in Table 7 and figure 5

**Table 7 Piagetian level comparisons per class**

Form	Average of 2Scale	Average of Scale	difference
7C	4.41	6.26	1.85
7G	5.83	7.19	1.36
7H	4.34	5.95	1.61
7R	4.63	6.11	1.48
7T	4.90	6.13	1.23
7Y	4.41	6.19	1.78

All pupils have continued to develop during the intervention but there is no significant difference in the mean increases.

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## Appendix 1: Technical Terms

### 1. The Piagetian scale

Name	Short form	Numerical
Formal Generalisation	3B	>=9
Mature Formal	3A/3B	8
Early Formal	3A	7
Concrete Generalisation	2B*	6
Mature Concrete	2B	5
Mid Concrete	2A/2B	4
Early concrete	2A	3
Pre-operational	1A-1B	1-2

### 2. Types of statistic

The statistics in your report are of two types. Mean level and Mean percentile have to be calculated from those pupils who had 1 item or more correct on the test. However schools with very low entries have some pupils who are unable to score at all. We have included all these pupils when we look at Histograms and Boxplots, and when median, or quartiles are reported.

**Histogram:-** The histogram shows the distribution of Piagetian level in your cohort. Each bar represents the number of pupils at a particular Piagetian level. We use a standard presentation of half level steps, so that you can see the distribution of pupils within each Piagetian level.

**Boxplots:-** The boxplot is the best way of comparing the overall distribution of levels of your pupils with other comparable data. The central rectangular plot contains the middle fifty percent of your pupils. The line within this is the median, the Piagetian level of the pupil who, when the marks of each student are arranged in ranking order occupies the middle position. The two vertical bars (whiskers) above and below the central box extend across the main body of pupil scores; those pupils whose scores are extreme outliers are shown as individual points (small circles)

**Percentiles:-** Conversion of data to percentiles involves mapping ranges of data onto a linear scale from 0 to 100. This is best explained by example. If there are 5400 secondary schools in the country and a school is 63rd from the top in its GCSE statistics then its percentile ranking is 98.8 calculated as below:-

$$[ 100 * (5400 + (1-63))/5400]$$

## Appendix 5d: Précis of changes to Science Reasoning Test (SRT) norms

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In the 1970s the CSMS team (Shayer & Wylam, 1978) surveyed 12,000 students aged 9 to 16 year old in Britain to produce normative graphs which showed the distribution of cognitive levels for this age group and therefore their expected progression (pg 12). There has been, however, a recent review of the SRTs by Shayer, Ginsburg & Coe (2007) in light of the plenitude of research into standards and achievement in British schools. The study was carried out in conjunction with the University of Durham using the CEM centre's MidYIS data which is a considerably larger database than the SRT one. Sixty nine schools were found to have matched data using Ginsburg's database with the MidYIS test (our school being one of them) for 2000 to 2003. Using the MidYIS norms, estimates were made about the performance of students nationally with the SRT -Volume and Heaviness - and comparisons were made with the 1976 data for the SRTs. The results showed a large decline in the mean score for both girls and boys with a greater decline for boys. In addition, the comparison between the four years, 2000 -2003, showed a steady decline. A second review was carried out by Shayer & Ginsburg (2009) on the two main post-tests SRT III, Pendulum and SRT IV, Equilibrium in Balance. Eight schools allowed their Year 8 students to be formally tested with SRT IV and/or their Year 9 classes with SRT III, which gave thirty-nine classes to compare to the established 1976 norms. Whilst there were slight changes in the mean levels of each test, which were not seen as significant, there was a significant reduction in the proportion of students attaining formal operational thinking for both boys and girls and with both tests (SRT IV, showing the greatest decline).

In summary, both these papers have contributed to an increased level of uncertainty in using SRTs to measure cognitive gains. Appendices 4a, 4b and 4c show the reports and analysis carried out by Denise Ginsburg on the SRT scores – pre and post tests - of the students participating in the RBT. The results are used to support the findings of the RBT.

## TASK II

### SCIENCE REASONING TASKS

NAME .....

TODAY'S DATE .....

BOY OR GIRL .....

CLASS .....

SCHOOL .....

DATE OF BIRTH .....

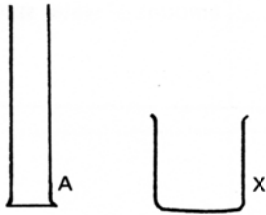
day

month

year

### VOLUME AND HEAVINESS

1.



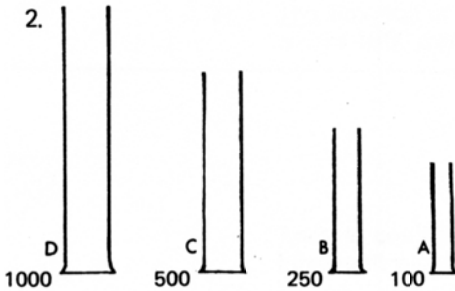
(tick the best answer)

A has more .....

less .....

the same ..... amount of water compared with X.

2.



Do these cylinders all have the same amount of water?

YES .....

NO .....

If you answered "NO" write down which has most .....  
(A/B/C/D)

3.a) The pop-corns have less .....

more .....

the same ..... amount of maize, compared with the grains.

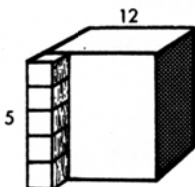
b) The pop-corns weigh more .....

less .....

the same ..... compared with the grains.

4.

(show your working here)



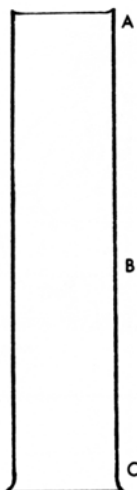
What is the volume of this plasticine block, in cubic centimetres?

Your answer .....

Correct answer .....

5. How much water will spill over when the plasticine is all under water? .....

6.



You see that water spills over when the block is lowered to A.

If it is lowered to B instead, will more .....

less .....

the same ..... amount of water spill over ?

If it is lowered to C instead, will less .....

more .....

the same ..... amount of water spill over ?

7.



What will the new volume-reading be?

.....

8.

If the plasticine is made into a ball, will the level be the same .....

higher .....

lower ..... ?



9.

If the plasticine is made into a cylinder, will the level be the same .....

higher .....

lower ..... ?



10.

If the metal block is lowered in, will more .....

less .....

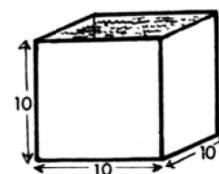
the same ..... amount of water spill over ?

Why?

.....  
.....

- 11.
- a) Will this flat piece float .....  
sink ..... ?
- b) Will this small flat piece float? YES .....  
NO .....
- c) Will this tiny piece float? YES .....  
NO .....

- 12.
- a) This box, full of dry-cleaning fluid weighs 1500 grams.



Another box (twice as tall)  
filled with water weighs 2000 grams.

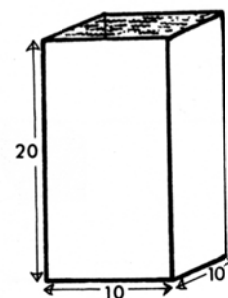
Would the box with the dry-cleaning fluid

float .....

sink ..... in water?

How did you work out your answer?

.....  
.....



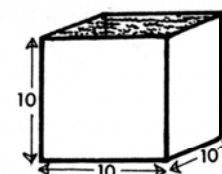
- b) When this box is emptied, and filled with alcohol it weighs 850 grams.

Will it float .....

sink ..... in water?

How did you work out your answer?

.....  
.....



13. a)



How do you think Archimedes measured the old and the new crowns' volumes to compare them, using a measuring cylinder ?

.....

.....

- b) Archimedes then weighed the two crowns and found that the new, bigger crown weighed more than the old one. Nevertheless he said that the new crown had some lighter metal in it.

How do you think he worked it out?

.....

.....

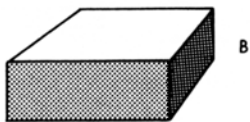
.....

14.



Both blocks are made of the same brass.

A weighs 60 grams, and its volume is  $15\text{cm}^3$ .



B weighs 160 grams.

What is its volume? ..... $\text{cm}^3$ .

How did you work out your answer?

.....

.....

# TASK IV SCIENCE REASONING TASKS

NAME .....

TODAY'S DATE .....

BOY OR GIRL .....

CLASS .....

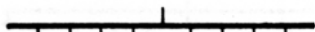
SCHOOL .....

DATE OF BIRTH .....  
day month year

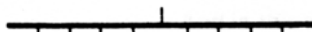
## EQUILIBRIUM IN THE BALANCE



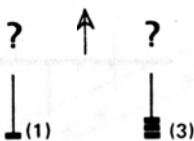
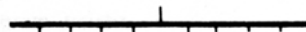
1.



guess



ans.

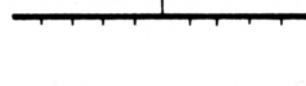


Explain:

2.



Explain:



3.

If I add 100 grams to the 400  
how much must I add to the 200 to keep it balanced?

1st try

.....

2nd try

.....

4.

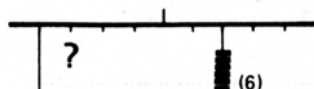
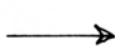
If I move the 400 to position 2,  
to which hole must I move the 200?

.....

.....

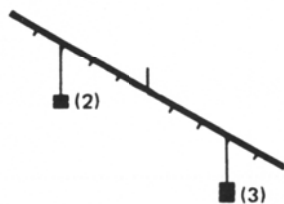
5.

What must I hang here  
to make this balance?



.....

6.



Make this balance by moving the weights.

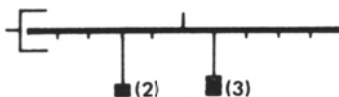
guess



ans.



7.

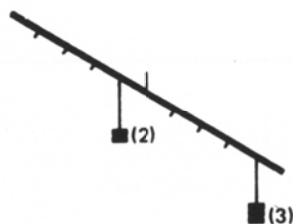


Moving in one place.

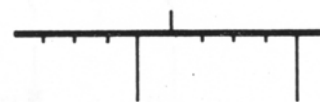
Explain:

How will it look?

8.



Without changing the position of the hangers, rearrange the weights to make this balance.



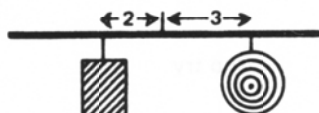
9.



These are in balance. If I move the (3) out one unit, how far must I move the (2) to keep the balance?

..... units

10.



These two balance.

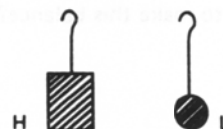
a) Which is heavier? .....

b) How much heavier is it? .....

11.

Can you give a general rule which connects weights and distances and whether the system balances?

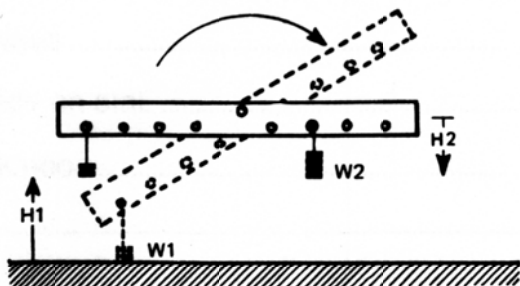
.....  
.....



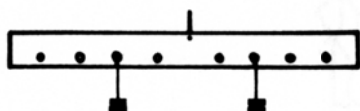


12. Another way of looking at the problem

"How are the rises and falls of weights related?"



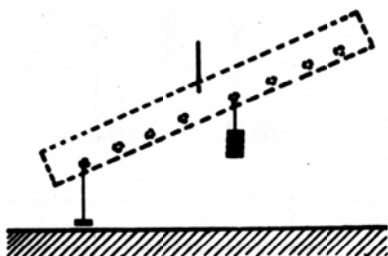
The 400 gram weight on hole 2 drops ..... cm  
which raises the 200 gram weight on hole 4  
through ..... cm.



Here one weight rises ..... 13 ..... cm  
while the other falls ..... 13 ..... cm.



And in this case the 300 gram weight  
is raised .... 6 ..... cm by the 100 grams falling 18 ... cm.



How far must the 400 gram weight fall in order  
to lift the 100 gram weight through 20cm?

.....

13. What explanation might you give to an intelligent friend who wanted to understand WHY it is that a LIGHT weight can lift a HEAVY weight and come to balance?  
Look at the WEIGHTS ( $W_1$  and  $W_2$ ) and the HEIGHTS ( $H_1$  and  $H_2$ ).

### Questionnaire

#### *PD input in terms of understanding teachers' background*

Cordingley (2007) found, when looking at the role of specialists, that in over half the studies specialists took into account teachers' starting points with one study actually focusing on possible barriers that could have affected teachers' ability to implement a new strategy. It was decided to use the established questionnaire, THEO (*teacher's appreciation and practical understanding of some psychological principles of the innovation*), which had been devised and used by Adey (2004) as part of testing a CA implementation model. The reason for using the questionnaire was that it had been specifically made to consider teachers' understanding and practical applications of the CASE pedagogy.

In the introduction session during the first week of academic year, when I met all three teachers collectively, I explained that the purpose of the questionnaire in terms of my role as a trainer was to understand their starting points in more detail; in addition it was important to have data for the RBT to give an indication of their theoretical starting points. In September 2007 shortly after the initial meeting, all teachers were given the questionnaire in an envelope and asked by me to complete it privately and return it to me in the envelope provided. The questionnaire can be found in appendix 7a. The results were processed by looking at individual responses, as well as comparisons between teachers, to see if there were any responses that indicated that the participant teachers might have had a barrier to overcome based on the pedagogy that underpins CASE. The use of the questionnaire was as a PD source to take into account teachers' starting points. It can be found in appendix 7a and a summary of its findings in appendix 7b.

### INSET sessions

#### *PD input in terms of the theoretical underpinnings of CASE as well as an opportunity for all CASE teachers to collaborate and reflect*

## Appendix 6: Summary of PD inputs

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All teachers in the science department, especially those teaching Year 7 and 8 classes, were invited to participate in the INSET training using the BP INSET pack (Adey, 1993) and Professional CDrom (Adey et al., 2003), which was run by me over the course of the academic year. I ran six sessions, one every half term after school, which were scheduled to last one hour. The three teachers involved in the research were asked to attend all sessions. All teachers who attended the sessions were asked to give feedback on the usefulness of the sessions which was used by me to inform the planning and delivery of subsequent sessions. The main purpose of the sessions was as a PD process where mediating factors of reflection and collaboration were evident at the beginning of the sessions when teachers were invited to provide feedback on their experiences to the whole group. Anecdote –telling, based on Bell’s (1994) paper on PD, was encouraged through teachers being invited to share their experiences from recent CASE activities as well as curriculum lessons. The PowerPoint presentation handouts for each session can be found in appendix 8a. The written feedback from these sessions was used in the planning for subsequent sessions; these can be found in appendix 8b. At the end of the last session, a questionnaire was given to all teachers to summarise the usefulness of the INSET sessions. This was devised so that I could have a record of how many sessions every science teacher in the department had attended and how helpful they had found the sessions on a practical, pedagogical and professional level; a summary of the completed questionnaires can be found in appendix 8c.

### **Journal**

#### *PD Input - a mediating factor of reflection*

In terms of researcher journal, Einenhardt (2002) emphasises the overlap in case study research between data collection and analysis, advocating the use of field notes by researchers; she posits that this allows for a more flexible approach where adjustments can be made to the research based on early analysis. Lincoln & Guba (2002) advocate that some of

## Appendix 6: Summary of PD inputs

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the findings of a case study should be given over to the researcher's own experiences through a consideration of his/her conscious reflexivity, which reflects : '*intensely personal processes on the part of the researcher* (p207)'. I therefore kept a journal throughout the research; its primary use was to note down anything that stood out during a PD input and as a tool for reflection. In terms of teacher journals, Hewitt & Hewitt (2004), in their CA primary work which contributed to the literature review, asked teachers to use a 'learning log' to reflect on their PD. They found that only two out of eleven teachers found it useful, whilst all agreed on its merits. Simon & Johnson (2008), in follow-up studies to the argumentation project, asked teachers to write portfolios with one of the purposes being: '*to share reflective analysis with other colleagues* (p 669)'. They found that only half the teachers (four out of eight) produced a final portfolio, which they related to differences in personal motivation. Again whilst time to reflect was seen as important, teachers found it difficult to find the time to complete it on a regular basis. For the RBT, each participant teacher was asked to keep a journal where she/he would write a brief review of each CASE lesson taught and the development of her/his understanding through the INSET sessions. The teachers were given the journal which had information written inside (appendix 9) on the purpose of the journal, which was as a PD process where teachers and trainer reflected on their experiences of CASE. There were various issues relating to the use of the journals, which is expanded upon in the discussion.

### **Demonstration lesson**

#### *PD input of modelling*

Demonstration lessons are termed as a 'modelling' PD input by Cordingley (2007) and Joyce & Showers (2002). The plan was for me to do one demonstration lesson at the beginning of the year. Each participant teacher was asked to observe the agreed demonstration lesson using the observation template (Mbano, 2001). In addition, I used the recommendation by Adey (2004) to improve the use of demonstration lessons through giving the teachers a particular

## Appendix 6: Summary of PD inputs

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focus, which relates to Hopkins's (2002) focused observation. Questioning technique was selected as the primary focus because teachers' questioning skills are central to the CASE methodology (Adey & Shayer, 1994). Teachers were given the freedom to decide whether to have their demonstration lesson before or after their first observation. Teachers A & B selected to have the demonstration lesson after their first observation and teacher C before her observation. Teachers were asked in the semi-structured interview about the demonstration lesson, which helped to gain evidence about the role of modelling in PD, which contributed as evidence towards question 2.

### **Coaching**

#### *PD input – mediating factor of coaching*

In relation to Joyce & Showers's (2002) PD cycle, which includes experimentation, reflection and coaching, I met with each teacher individually to provide feedback on his/her lesson observation. Therefore, whilst the lesson observation was a method for data collection, coaching was a PD input; the participant teachers were asked about its usefulness in their respective semi-structured interviews. The commentary on strengths allowed for positive aspects to be focused on initially and the recommendation part allowed for specific areas in relation to the methodology to be discussed which included suggestions for improvement.

### **Calendar for the year**

The calendar for the academic year can be found in appendix 10. The beginning of the year involved me meeting with members of the Senior Leadership Team with responsibility for teaching and learning to outline the research. Permission had already been granted by the Headteacher, but at this stage I was able to give more detailed information about the study. I met with the three participant teachers, outlining the arrangements for the year and giving them their research journals. I used this meeting again to reiterate my multiple roles as a researcher and trainer and emphasised that the research was in no way related to my

## Appendix 6: Summary of PD inputs

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leadership role within the school. I pre-tested all the students during the first couple of weeks of term before any teacher taught CASE activity 1. The calendar shows the commitment that was needed by me as a trainer/coach as well as researcher throughout the research year.

## Appendix 7a: CASE Teacher Questionnaire

### CASE TEACHER QUESTIONNAIRE

As part of my research on teachers' professional development with CASE, please can you spend 20 minutes completing this questionnaire. Please remember that I will be using the information to reflect on how best to support you with your delivery of CASE lessons. I hope to use some of your answers as a discussion point in the first semi-structured interview. Please remember that my role is as a researcher and trainer not SLT.

**Your name:** .....

1. Do you have a specific role in the science department - e.g. Head of Science, CASE coordinator, Head of Biology, etc.

.....

2. In what years have you used Thinking Science lessons? (complete /tick the appropriate boxes)

Academic Year	Name of School	Which activities?	Year 7	Year 8	Year 9
PGCE year					
2001-2002					
2002-2003					
2003-2004					
2004-2005					
2006-2007					

- 3a** How many CASE INSET sessions have you attended?

(circle one)    0       1       2       3

- b** Have you attend the CASE Convention?       yes / no

If the answer is yes, how many Conventions? .....

## Appendix 7a: CASE Teacher Questionnaire

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- 4 Please make an estimate of the total departmental meeting time over the past two years devoted to discussion of CASE teaching methods. Do not count here either informal chats, or time in meetings spent on the administrative aspects of CASE (such as who is going to do what lesson next, or problems with apparatus). I am asking only for a 'guesstimate'.

less than 1 hour	<input type="checkbox"/>
1 to 3 hours	<input type="checkbox"/>
3+ to 5 hours	<input type="checkbox"/>
more than 5 hours	<input type="checkbox"/>

5. Apart from meetings, about how often do you have conversations with colleagues about CASE teaching methods?

10 times per term or more	<input type="checkbox"/>
5 to 10 times per term	<input type="checkbox"/>
less than 5 times per term	<input type="checkbox"/>

6. Do you think that is useful for teachers to observe or help in each others' classes when a new method is being introduced? Yes / no

Please explain your answer.

.....

.....

7. On average, how often does a colleague observe you or help in a your class when you are teaching CASE?

5 times per term or more	<input type="checkbox"/>
1 to 5 times per term	<input type="checkbox"/>
less than once per term	<input type="checkbox"/>

8. On average, how often do you observe a colleague or help in a colleague's class when they are teaching CASE?

5 times per term or more	<input type="checkbox"/>
1 to 5 times per term	<input type="checkbox"/>
less than once per term	<input type="checkbox"/>

9. To teach CASE properly, do you believe it is important to understand something of the underlying psychological theory? (circle one)

☐ essential

☐ fairly important

☐ not very important

☐ quite unnecessary



## Appendix 7a: CASE Teacher Questionnaire

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- 10.** If you were to run an INSET session for teachers new to CASE, would you consider including some learning theory in the session to be: (circle one)

essential

fairly important

not very important

quite unnecessary

- 11.** Please put one tick next to each of the following statements to show how much you agree or disagree with it. They refer to Key Stage 3 pupils (Years 7, 8, 9):

	<b>strongly agree</b>			<b>strongly disagree</b>
a. I am only happy if some specific content has been covered in every lesson.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Year 7 pupils are generally capable of reflecting about their own thinking.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. It does not matter if pupils sometimes leave a class a bit confused.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. I can give my pupils a lot of information, if they only listen and make good notes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Year 8 pupils can learn to check their own learning successes and weaknesses.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. At the end of a lesson, pupils should always have a clear record of what they have learned.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. The most effective learning experiences for pupils are those which they find a bit difficult.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Pupils have to construct knowledge for themselves. I can only arrange activities which enable them to do this.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Time spent helping pupils to develop their thinking will be repaid as better learning later.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Eventually, we always have to give pupils the information they need.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. In each lesson, it is essential to give pupils time to reflect on what they have learned or how they have been thinking.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. Ideally, I would like to aim to match the difficulty of teaching material more precisely to each child's ability.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Many thanks for your time.*

## Appendix 7b: Summary of Responses to Questionnaire

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- 1.** Do you have a specific role in the science department - e.g. Head of Science, CASE coordinator, Head of Biology, etc.

Teacher A: Head of Biology

Teacher B: Second in charge of  
Science Department

Teacher C: Head of KS 4 Science

- 2.** In what years have you used Thinking Science lessons? (complete /tick the appropriate boxes)

Academic Year	Year 7	Year 8	Year 9
PGCE year			
2001-2002	1-15 (C)		
2002-2003	1-15 (C)	16-30 (C)	
2003-2004	1-15 (C)	16-30 (C)	
2004-2005	1-15 (C) 1-15 (B)	16-30 (C)	
2006-2007	1-15 (C) 1-15 (B) 1-13 (A)	16-30 (C) 16-30 (B)	

- 3a** How many CASE INSET sessions have you attended?

Teacher A: 0

Teacher B: 1

Teacher C: 3

- b** Have you attend the CASE Convention?                      yes / no

If the answer is yes, how many Conventions? Teachers A & B no

Teacher C: yes 3 conventions

- 4** Please make an estimate of the total departmental meeting time over the past two years devoted to discussion of CASE teaching methods. Do not count here either informal chats, or time in meetings spent on the administrative aspects of CASE (such as who is going to do what lesson next, or problems with apparatus). I am asking only for a 'guesstimate'.

less than 1 hour Teacher A, Teacher B Teacher C

## Appendix 7b: Summary of Responses to Questionnaire

---

more than 5 hours

☐

5. Apart from meetings, about how often do you have conversations with colleagues about CASE teaching methods?

10 times per term or more Teacher C

☐

5 to 10 times per term Teacher B

☐

less than 5 times per term Teacher A

☐

6. Do you think that is useful for teachers to observe or help in each others' classes when a new method is being introduced? Yes / no

Please explain your answer.

Teacher A: Teachers observing a range of questioning and answering techniques will assist them to develop a wider range for their own lessons. Teachers helping in each others' classrooms during group work will maximise the likelihood of all pupils engaging with particular ways of thinking and being pushed into their discomfort zone.

Teacher B: I learn best when observing and doing

Teacher C: Gives teachers an opportunity to reflect on and discuss their practices, give support to each other

7. On average, how often does a colleague observe you or help in a your class when you are teaching CASE?

5 times per term or more Teacher C\*

☐

1 to 5 times per term

☐

less than once per term Teacher B Teacher A

☐

\* LSAs and PGCE students

8. On average, how often do you observe a colleague or help in a colleague's class when they are teaching CASE?

5 times per term or more

☐

1 to 5 times per term

☐

less than once per term Teacher C Teacher B Teacher A

☐

## Appendix 7b: Summary of Responses to Questionnaire

*To teach CASE properly, do you believe it is important to understand something of the underlying psychological theory? (circle one)*

*2. If you were to run an INSET session for teachers new to CASE, would you consider including some learning theory in the session to be: (circle one)*

**essential    fairly important    not very important    quite unnecessary**

*1. Teachers A & C put it was essential and Teacher B put it was fairly important.*

*2. All three teachers put it was essential.*

For the last part of the questionnaire the teachers were asked to put one tick next to each of the following statements to show how much they agreed or disagreed with it. The statements all refer to Key Stage 3 pupils (Years 7, 8, 9):

	<b>strongly agree</b>		<b>strongly disagree</b>	
a. I am only happy if some specific content has been covered in every lesson.	<input type="checkbox"/>	<input type="checkbox"/>	C B	A
b. Year 7 pupils are generally capable of reflecting about their own thinking.	A	B	C	<input type="checkbox"/>
c. It does not matter if pupils sometimes leave a class a bit confused.	A B C	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. I can give my pupils a lot of information, if they only listen and make good notes.	<input type="checkbox"/>	C	<input type="checkbox"/>	B A
e. Year 8 pupils can learn to check their own learning successes and weaknesses.	A C	B	<input type="checkbox"/>	<input type="checkbox"/>
f. At the end of a lesson, pupils should always have a clear record of what they have learned.	<input type="checkbox"/>	<input type="checkbox"/>	C	B A
g. The most effective learning experiences for pupils are those which they find a bit difficult.	A	C B	<input type="checkbox"/>	<input type="checkbox"/>
h. Pupils have to construct knowledge for themselves. I can only arrange activities which enable them to do this.	B A	C	<input type="checkbox"/>	<input type="checkbox"/>

## Appendix 7b: Summary of Responses to Questionnaire

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i	Time spent helping pupils to develop their thinking will be repaid as better learning later.	A C	B		
j.	Eventually, we always have to give pupils the information they need.		C	B	A
k.	In each lesson, it is essential to give pupils time to reflect on what they have learned or how they have been thinking.	A	C B		
l.	Ideally, I would like to aim to match the difficulty of teaching material more precisely to each child's ability.	B A	C		

### What does the Project involve?

- 30 activities
- Taught over a two year period
- On a basis of one activity every two weeks
- Designed as one hour lessons
- Professional development
- Intervention versus Instruction
- Cognitive Acceleration

### Psychological Models

- Piaget  
Cognitive Development
- Vygotsky  
Social Mediation/ Construction

### Development vs Learning

- *'The only good kind of instruction is that which marches ahead of development and leads it; it must be aimed not so much at the ripe as the ripening function.'*
- *'The only 'good learning' is that which is ahead of development.'*

### Instruction versus Intervention

- Carefully ordered
- Small packets, reinforced
- Changes of pace
- Lots of information delivered
- Pupils have notes to revise from
- Builds dependency
- Follow direction of argument
- Pupils often puzzled
- Very little information covered
- Not sure what they have covered
- Hard work
- Seems dangerous
- Builds Capability

### Reasoning Patterns

Classification	Correlation	Formal Models
Equilibrium and Compensation		Ratio and proportionality
Probability	Control and exclusion of variables	Combinations

### Five Pillars

Concrete preparation  
Cognitive conflict  
Social construction  
Metacognition  
Bridging



## Appendix 8a(ii): INSET II Handout

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CASE INSET – 15<sup>th</sup> November 2007  
Five pillars of CASE

Concrete Preparation  
Cognitive Conflict/challenge  
Construction  
Metacognition  
Bridging

### Concrete Preparation

- Familiar with the terminology and the context
- Key words identified and discussed
- Opening discussion

### Cognitive Conflict

- Development of the reasoning pattern
- A surprising event which does not fit in with their preconceptions
- Contradictory ideas

### Construction

- Active process
- Constructivist approach
- Construct the Reasoning Patterns of Formal Operations
- Feedback loop between accommodation and assimilation

### Metacognition

- Thinking about one's thinking
- Consciousness
- Explicit rather than implicit
- Articulation
- Reflection

### Bridging

- Reasoning patterns linked/applied to other contexts – near or far transfer
- Methodology adopted in other lessons

### CASE INSET – session 3

Thursday 7<sup>th</sup> February  
Vygotsky  
Five pillars of CASE  
Video clips continued

### Vygotsky

- ✦ Russian, died aged 37 years old
- ✦ Extensive writings on various disciplines including psychology – mainly cognition

### Instruction vs Intervention (Learning vs Development)

- ✦ *'The only good kind of instruction is that which marches ahead of development and leads it; it must be aimed not so much at the ripe as the ripening function.'* (Vygotsky 1986)
- ✦ *'The only 'good learning' is that which is ahead of development.'* (Vygotsky 1978)

### Zone of Proximal Development ZPD

- ✦ "the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers"

### Piaget & Vygotsky

- ✦ Piaget
  - ✦ Interaction of the child with the events in his/her environment
- ✦ Vygotsky
  - ✦ People working together – social /mutual development

### Pillars

- ✦ Concrete preparation
- ✦ Cognitive conflict
- ✦ Construction
- ✦ Metacognition
- ✦ Bridging



## CASE INSET 4

- Review of activities taught
- Does CASE improve attainment in CORE subjects?
- What is the difference between social construction and metacognition?
- Groupings in CASE lessons – review of current practice



## Effects on GCSE: 'added value'

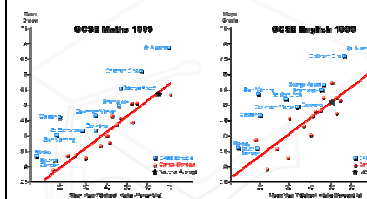
1. Find levels of cognitive development of all at school entry
2. Find relationship between non-CASE schools' entry level and GCSE grades on leaving school 5 years later
3. See by how much CASE schools' grades exceed these expectations



Thinking Science Professional Edition / 03.7



## ... and the transfer effect



Thinking Science Professional Edition / 03.8



## ... but such effects are not attained easily

- You cannot teach someone to think better, only offer opportunities for their minds to be stimulated and stretched.
- Constructing new meaning is an individual, inside-the-head thing.
- The effects are cumulative, and the development path unique to each pupil.
- You often cannot list, or see, specific outcomes from a single 'thinking' lesson. Being too specific risks reducing thinking to a set of ready-to-apply techniques. (This is *training*, not development.)



Thinking Science Professional Edition / 03.9



## Schemata and Social Construction

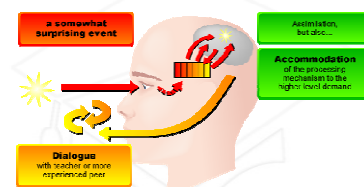
(or, in English, *general* ways of thinking, and thinking with a little bit of help from your friends)



Thinking Science Professional Edition



## Cognitive Conflict Generates *Talk*



Thinking Science Professional Edition / 03.4



## Some Questions to Encourage Social Construction

- Do you agree? Why/why not?
- Are the results of this practical investigation reliable?
- How do you know?
- What do you mean by that?
- Are you contradicting each other?
- Are there any other alternatives?
- Explain why you think that.



Thinking Science Professional Edition / 03.5



## Metacognition

- So far, our students have been developing their *schemata* (general ways of thinking)...
- But how **conscious** have they been about their own thinking?

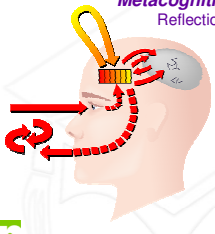


Thinking Science Professional Edition / 04.2



## Appendix 8a(iv): INSET IV Handout

**Metacognition:**  
Reflection on one's own thinking



- How did I solve that problem?
- What was difficult?
- What mistakes did I make?
- What have I learned about solving problems?

Thinking Science Professional Edition / 04.3

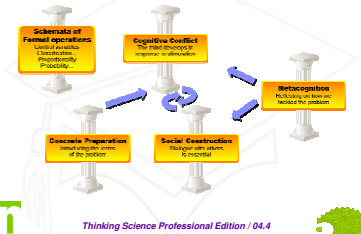
**Metacognition (thinking out loud) ...**

- ... makes unconscious, implicit thinking conscious and explicit
- ... allows students to expose their own thinking for inspection - by themselves and by others
- ... makes that kind of thinking more available for use again, in a new context.

*How can we encourage our students to be metacognitive?*

Thinking Science Professional Edition / 04.5

**Another Pillar....**



Thinking Science Professional Edition / 04.4

**Some Metacognitive Questions**

- What do you think?
- Why do you think that?
- How do you know?
- Do you have a reason?
- Can you be sure?
- Is that now the same thing as you first thought?
- What is your reason for saying that?
- What made you change your mind?

Thinking Science Professional Edition / 04.6

**How Do You Group Your Students?**

**Some people say ....**

- if you have odd numbers (3, 5), then one is always left out;
- I number the students as they come in, 1, 2, 3, ... 8; 1, 2, ... 8, etc., then get all the 1s to work together, all the 2s and so on;
- I do the same sort of thing by giving out cards - all reds together, etc.

Thinking Science Professional Edition / 04.7

**Grouping students, cont.**

**Others say ....**

- I establish groups early in the year, and keep them the same;
- I find mixed ability groups work well for *Thinking Science*;
- I always insist on mixed gender groups;

**What do *you* think?**

Thinking Science Professional Edition / 04.8

**The 'Birmingham Method'**

This is a way of grouping students used in some Birmingham CASE schools, where classes often have a wide range of ethnicities and home languages:

Students choose one 'buddy', a friend. That pair always works together. On different occasions, the teacher arranges different pairs to work together, so in each group of four I'll find my friend for support, and two others I may need to listen to and explain things to.

Thinking Science Professional Edition / 04.9

### CASE INSET – Session 5

Wednesday 21<sup>st</sup> May 2008

#### Agenda

- Feedback – lessons learned from recent lessons
- Group work
- Bridging
- Instruction versus intervention

#### How Do You Group Your Students?

##### Some people say ....

- if you have odd numbers (3, 5), then one is always left out;
- I number the students as they come in, 1, 2, 3,...8; 1, 2, ... 8, etc., then get all the 1s to work together, all the 2s and so on;
- I do the same sort of thing by giving out cards - all reds together, etc.

*Thinking Science Professional Edition - 180.7*

#### Grouping students, cont.

##### Others say ....

- I establish groups early in the year, and keep them the same;
- I find mixed ability groups work well for *Thinking Science*;
- I always insist on mixed gender groups;

**What do you think?**

*Thinking Science Professional Edition - 180.8*

#### The 'Birmingham Method'

This is a way of grouping students used in some Birmingham CASE schools, where classes often have a wide range of ethnicities and home languages:

Students choose one 'buddy', a friend. That pair always works together. On different occasions, the teacher arranges different pairs to work together, so in each group of four I'll find my friend for support, and two others I may need to listen to and explain things to.

*Thinking Science Professional Edition - 180.9*

#### Harnessing the 'Group Brain'

- Ask open-ended questions.
- Ask the whole class to think about the responses given by each group and spend two or three minutes discussing again.
- Establish that you may ask anyone in the group for the group answer (they speak for the group).
- You can use oral multiple choices 'Is it this or this?' to get the groups started on a discussion.
- Ask groups to write down an answer then get a few groups to read theirs out.
- Ask how confident pupils feel about what they know.

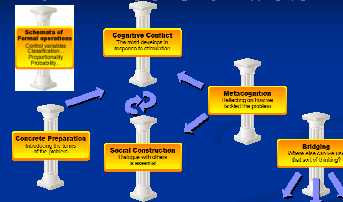
*Thinking Science Professional Edition - 180.10*

### Completing the Model

... and questioning for cognitive stimulation

*Thinking Science Professional Edition*

#### Six Pillars of CASE Wisdom



*Thinking Science Professional Edition - 180.11*

### Bridging 1

... Linking the thinking of *Thinking Science* to other areas in the curriculum:

- 'Where else might you classify things in two different ways?'  
*applications of a schema in different contexts*
- (in a regular science lesson, talking about concentration or velocity) 'Do you remember the *Thinking Science* lesson on gears, or the wheelbarrow ... What sort of thinking did we use? Can we use that here?'  
*(drawing on schema from TS lessons for use in regular science)*

*Thinking Science Professional Edition - 10.2*

### Bridging 2

... Using the pedagogy of *Thinking Science* in other areas in the curriculum:

This happens at a more intuitive, less conscious level ... you might find yourself encouraging more social construction in your normal teaching, or asking metacognitive questions.

*Thinking Science Professional Edition - 10.2*

### Give Them 'Time to Think'

- Increase 'wait time' to 10-15 seconds

*'(usually) react to yourself' after you ask a question ... resist the strong temptation to jump in with an answer yourself!*

- Sometimes use a rule: One minute hands down for 'think time'

*Only take answers after a minute of quiet*

'Time to Think' activities promote Metacognition

*Thinking Science Professional Edition - 10.3*

### Remember Teacher 'Think Time' as well

Take time before you respond. You may:

- see more in the answer;
- reply in a different way; or
- the pupil may come back with more or change an answer.

... anyway, the learning will improve

*Thinking Science Professional Edition - 10.4*

Some questions for ...

### Clarifying Thoughts

- I'm confused, help me to understand why ...
- Are you saying that ...?
- So you think ...?
- I think you mean ... am I right?
- Does everyone else agree with you or not? If not, why not?

*Thinking Science Professional Edition - 10.5*



### Normal Based Concept Lessons

- Formula of ionic salts

Can you think how you could teach this concept in a constructivist approach rather than instruct the rule and then get the students to practise.


## CASE INSET 6

Monday 30<sup>th</sup> June 2008

## Agenda



- Review – feedback from recent lessons
- Pulling it together
- "Hooks or bridging examples" – linking to the different reasoning patterns




## Pulling it Together ...

... and building it into the system



Thinking Science Professional Edition


## Self-Audit

- Do my questions only need instant one-word answers?
- What do they test - knowledge or understanding?
- Do I give the class enough time to think about the answer to the question?
- Do I quickly accept the correct answer?
- Do I follow up a correct answer by asking how or why the pupils knew it was right?
- Do I ask the pupil to explain her answer, if right or wrong, and give her time to do this?
- How do I deal with wrong answers?



Thinking Science Professional Edition / 06.2


## Pathways to Integrating TS Methods





Thinking Science Professional Edition / 06.3

## A Lesson Structured to Promote Thinking




Thinking Science Professional Edition / 06.4






## Progression in Thinking Science

...across the 30 activities and their schemata





Thinking Science Professional Edition / 06.5

## Planning an instruction-based lessons

- Identify the reasoning patterns used to understand the concept
- Consider the Piagetian levels
- Think of misconceptions that might help generate cognitive conflict
- Topics
- Respiration
- Eco-systems
- Equilibrium

## Appendix 8b: Feedback from CASE INSETs

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### Session 1

*I asked for feedback, posing the following questions:*

- *What you found useful?*
- *What you would like covered in the next INSET? E.g. more discussion on theory or looking at actual lessons.*

Teacher	Comment
Year 7 CASE Teacher (code Teacher D)	<p>I thought it was great to hear you speak positively about Piaget having spent some time writing about Margaret Donaldson's views on his ideas.</p> <p>I really enjoyed the discussion of theory and that links with what actually happens in the classroom. I look forward to the next INSET when I will have taught it for a while and see the realities of teaching CASE ( I haven't taught it since the first year I arrived here) and I guess will have more questions about the practicalities.</p> <p>But to start with it was just good to be thinking about learning and development.</p>
Year 7 CASE Teacher (code Teacher E)	<p>Useful: advice on what is the most important aspect of CASE lessons, and on timings. Reminder of theory behind it and what stage the categories in the CASE test refer to.</p> <p>Next time: may be running through a lesson ( a difficult one) to emphasise where the important things should be happening (where is the cognitive conflict, important to stress this, this question is trying to access this level of timing etc.)</p>
Participant Teacher B	<p>I found the ideas about the general processor and whether or not a child develops all of their reasoning skills together or at different paces to be interesting.</p> <p>The idea that you didn't have to go through the different stages of understanding (e.g. pre=operative) in order was made clear this time.</p> <p>For the next INSET – looking at actual lessons with focus on questioning for me.</p>

## Appendix 8b: Feedback from CASE INSETs

### Session 2

*I asked for feedback, asking what you:*

- *found useful?*
- *would like more information on?*
- *will use in the next CASE lesson?*
- *think we could do to make a CASE video for other schools to use as part of in-service training*

Teacher	Comment
Head of Department	<p>More focussed on actual lesson content than last time- far more interesting and useful, especially for less experienced teachers, although I realise that the 'background theory' is important.</p> <p>More real videos would be very interesting/useful. Perhaps we could make one of our own?</p> <p>Always good to have the five pillars re-emphasised.</p>
Year 7 CASE Teacher (code Teacher E)	<p>I thought it was a really useful session – the importance of the cognitive conflict and the importance of emphasising this; the fact the other pillars are implicit in the lessons plans and don't need such strong emphasis. The idea of planning around the cognitive conflict and really identifying and pushing the point is one that I will take away to my lessons, as is the idea of getting the students to come with definitions of key terms and using these in lessons.</p> <p>The ability of even the very able students to metacognise and really interesting and when I tested this out in my next lesson I realised it was right – very bright girl had real difficulty putting into words the pattern in the cooling graph for oil.</p> <p>I would like you to run through the most effective way to use the interactive software for CASE as it is a good resource with the interactive data tables and things, but seems to give away the answers sometimes. I think if we were to be videoed doing CASE lessons for a nice compilation.</p>
Participant Teacher C	<p>I found it useful to be able to discuss with the rest of the staff resources that I knew quite well but hadn't seen in a while.</p> <p>The discussion parts are more useful for me than the 'teaching' from ML as I feel I know the background to CASE quite well now and know the links to Vygotsky in terms of social construction and ZPD, and Piaget.</p>
Participant Teacher B	<p>It was really interesting to find out others' thoughts about their CASE teaching recently.</p> <p>Watching the video of CASE lessons and the theory behind them was very good.</p> <p>Really keen to learn more about moving the discussion over to them and away from me.</p> <p>I think that an in-house video of good practice would be excellent and something that we should aim towards.</p>
Participant Teacher A	<p>Found useful – listening to strategies you and other teachers use in construction phase ( turn to neighbour to discuss, try not to use leading</p>

## Appendix 8b: Feedback from CASE INSETs

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	<p>questions and using phrases such as can anyone help her out?)</p> <p>Would like more information on –‘perceived ability’ and ‘cognitive aims’.</p> <p>I will try to facilitate named student to steer the group when they are struggling too much</p> <p>Video I think named student would be a great student to model using certain techniques to stretch higher ability on the video. If you could find an extreme lower ability student...(and work with the idea of motivation and lower ability/perceived ability) and a good representation of the average student and then clearly demonstrate strategies which assist all abilities to meet their cognitive aims of the lesson.</p>
AST in Religious Education– Philosophy for Children specialist	<p>Found PowerPoint handout useful and the way in which your familiarity with the method enabled discussion of common difficulties and misconceptions.</p> <p>I’d be interested in developing a better understanding of cognitive conflict, by seeing more examples identified as I’d like to consider to what extent we’re creating these as a matter of course in RE. It seems the Socratic style of questioning is all about creating conflicts, but CASE appears so useful as it sets the conflict in the context of a broader learning process, yet within the timescale of a lesson.</p>



## Appendix 8b: Feedback from CASE INSETs

### Session 3

*I asked for feedback on what you found useful and what would be helpful in the future.*

Teacher	Comment
Year 7 CASE Teacher (code Teacher D)	It was a useful session and I always enjoy listening and discussing different educational theories and then looking at the practical application of these – very stimulating and thought-provoking. Having missed the last session and only watching a small taste of the video I am really keen to see more as watching others give CASE lessons is very illuminating about one's own practice. I haven't actually watch you teach yet- so next time you are teaching I would be interested to come along.
Year 7 CASE Teacher (code Teacher E)	The emphasis on identifying the 5 pillars was really useful – I have never been really 100% on recognising these before. Now I can easily identify them. And the idea of building the different pillars at different stages of a lesson, and not necessarily treating them as completely separate parts of a CASE lesson. And the link to the theory – Piaget and Vygotsky and the educational development. Not sure what I would like covered next time.
Participant Teacher B	Re-enforcing the different phases involved in a CASE lesson was useful as was the video clips showing elements of them within a lesson.
Participant Teacher A	I found the last CASE INSET very useful because: It was an opportunity to analyse a lesson which was beneficial because it helped me to identify (on paper for future reference) what was happening at each stage. The lesson script was detailed enough that I could use the dialogue for particular sections if I need assistance in improving any of the five pillars. The video helped me to see the five pillars in action and demonstrated good and poor practice.
Supply teacher, joined in spring term A	I found the video then our own views on the video extremely helpful – to be able to observe then talk about I felt gave me a better understanding of what I would do for a CASE lesson. The handouts were good but I did feel a bit lost since it was my first session and I didn't know what has been going on in the previous ones. But I am excited to start these with my Year 8s since I feel that it is an important aspect of learning.
Supply teacher, joined in spring term B	It's a little bit difficult for me to comment in too much depth without experience in CASE. But a few things: I enjoyed being reminder of the theory – it's easy to forget university content. I liked seeing the stages and then an example I liked that there was a platform to share our views and experiences I thought it was useful to then see the theory enacted I thought the transcript could have provided better examples of the stages – towards the end there was not great evidence of metacognition and bridging I didn't think the video provided the best example of good practice

## Appendix 8b: Feedback from CASE INSETs

### Session 4

*I asked for feedback on what went well (www) and even better if (ebi)*

Teacher	Comment
Head of Science	<p>It was: informative and understandable, illuminating especially for younger, less experienced/foreign teachers; put much of what we teach into perspective, made teachers more aware of the different Piagetian levels of our students; explained exactly these aspects of CASE teaching, made the CASE lessons a lot more understandable and enabled teachers to teach the CASE methodology effectively.</p> <p>Having discussed the delivery with the teachers present they thought: They enjoyed the presentation very much and gained enormously due to the points above; they applied particularly to non-UK trained staff; really prepared them for aspects of CASE teaching.</p>
Year 7 CASE Teacher (code Teacher E)	<p>www: I liked the general discussion at the start – was useful to share ideas and hear other people’s thoughts and opened up areas for discussion that I hadn’t really thought about before. The critique of the video was useful – discussing why not good practice. It was a really good session- the metacognition idea is something I’ll try and incorporate more into lessons - particularly A Level I was thinking where I am often happy to leave it at the students constructing ideas.</p> <p>ebi: I was thinking it’s strange that this resource hasn’t been updates for about 15 years, and we are still using the original worksheets. There aren’t many textbooks/resources that last this long unchanged! How come CASE hasn’t been updated? There seem to be a few flaws in a lot of the lessons – how come these haven’t been ironed out in revised editions? Why hasn’t it been modernised like most things have been to make it a bit more 21<sup>st</sup> C friendly? I always think the old, poor quality worksheets put students off a little bit... Would be interested to know why it hasn’t changed.</p>
Supply teacher, joined in spring term A	<p>www: watching the video and talking through past experiences were really helpful. It’s always good to hear others struggling with CASE or used to struggle with it. ebi: I think not only critiquing the video but demonstrating or saying a way to improve the mistakes being made.</p>
Supply teacher, joined in spring term B	<p>Again it was good to share professional dialogue and be encouraged to question and evaluate your own practice. It was good to hear about things that were working or tips for success from other teachers.</p> <p>It’s also good to hear about things that have not worked so well, so we can think about things to improve or flaws in the system.</p> <p>I didn’t mention it, but the Thinking Science programme is not installed on all computers – that makes it difficult for using the interactive worksheets. I think it is beneficial to have the background theory in understanding why you do certain things in a particular order</p> <p>It was useful to see the video, but would have been great to see how CASE lessons works in our school, with our students. Therefore, I would like to find a time to observe a CASE lesson. It would be good if I knew the students (ie one of my classes) so that I can see how they respond to another teacher.</p> <p>Thanks for the inspiration and for the great resources. I think this is a really valuable programme and I really enjoy teaching it.</p>

## Appendix 8b: Feedback from CASE INSETs

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### Session 5

*I asked for feedback on what went well (www) and even better if (ebi)*

Teacher	Comment
Year 7 CASE Teacher (code Teacher E)	www: The feedback from teachers about their recently taught CASE lessons; the video clips of lessons. Ebi: you said a while back you would give us a list of introductions that you have used ( and found to work!) in the past for different CASE lessons. More hints and tips on effective group discussion.
Supply teacher, joined in spring term A	www: I really enjoyed hearing other experiences from the teachers. It helps to see areas of improvement for myself to see where other teachers may have had difficulties or success. Makes me feel a bit better that other people have struggles with certain cases or certain students didn't understand the concepts. ebi: may be picking certain CASE lessons and go through it especially with www and ebi experiences and alternative ways to deliver it.
Supply teacher, joined in spring term B	www: sharing of ideas about success stories and challenges; video clips; linking the lessons to the theoretical framework; we always know where we should be up to and where we should be heading. Ebi: we kept a record of tips for each lesson; we could discuss the effects of groups choices in more detail; we could discuss ideas about wait time in more detail.

**Feedback on CASE INSET – Monday 30<sup>th</sup> June 2008**

Name\_\_\_\_\_

Number of years teaching CASE\_\_\_\_\_

1. How many of the six INSET sessions did you attend?
  
  
  
  
  
  
  
  
  
  
2. Can you summarise what you found helpful on a:
  - Practical level
  
  
  
  
  
  
  
  - Pedagogical level
  
  
  
  
  
  
  
  - Professional level
  
  
  
  
  
  
  
3. Have you ever had the opportunity to be observed teaching CASE or observe a colleague?
  
  
  
  
  
  
  
  
  
  
4. What would you like covered in any further INSET or coaching sessions?

Comments

Thank you for taking the time to complete this review

## Appendix 8c: Feedback on CASE INSET

### Participant Teachers

Teacher A Question	Teaching CASE for 2 ( 1 properly) years
1 How many of the six INSET sessions did you attend?	6
2. Practical	No comment made
2. Pedagogical	INSET sessions, observations, conversations, interviews, feedback, reading, planning
2. Professional	The feedback was the most effective tool I used to develop my lessons
3. Have you ever had the opportunity to be observed teaching CASE or observe a colleague?	Yes ( research 3 observations) I have been fortunate enough to have been trained in CASE. The training has given me the opportunity to be observed three times and I have also observed an experienced CASE teacher
4 What would you like covered in any further INSET or coaching sessions?	Overview of progress

Teacher B Question	Teaching CASE for 4 years
1 How many of the six INSET sessions did you attend?	6
2. Practical	Grouping of students, questioning skills
2. Pedagogical	Understanding the ability of students at different levels
2. Professional	How to approach the teaching of difficult concepts
3. Have you ever had the opportunity to be observed teaching CASE or observe a colleague?	Yes ( research 3 observations)
4 What would you like covered in any further INSET or coaching sessions?	Other ideas of links into lessons

Teacher C Question	Teaching CASE for 7 years
1 How many of the six INSET sessions did you attend?	6
2. Practical	Talking about equipment/practicals that don't work, sharing ideas that we had at previous school.
2. Pedagogical	Reflecting on my experience of teaching CASE whilst discussing it with 'novice' CA teachers; linking it to my knowledge of Piaget and Vygotsky etc.
2. Professional	Opportunity to work with other colleagues in the department
3. Have you ever had the	Yes ( research 3 observations)

## Appendix 8c: Feedback on CASE INSET

opportunity to be observed teaching CASE or observe a colleague?	
4 What would you like covered in any further INSET or coaching sessions?	Linking to planning new CA activities in Science

### Non-participant members of the department

Supply Teacher B Question	Teaching CASE for 1 year
1 How many of the six INSET sessions did you attend?	4
2. Practical	The lessons are all set out well and it is easy to request materials. Great to hear feedback about lessons and new hooks. Easy location, short meetings, comfortable surroundings
2. Pedagogical	Reengagement with theoretical knowledge from teacher training. A framework to apply to other lessons
2. Professional	Professional dialogue reinvigorates me and my practice Becoming a professional of learning and teaching not just science.
3. Have you ever had the opportunity to be observed teaching CASE or observe a colleague?	No – would have really liked to see someone engage in CASE with my class to see it from another perspective
4 What would you like covered in any further INSET or coaching sessions?	Wait time Group choices (who should work together) Updating the materials

Teacher E Question	Teaching CASE for 2 year
1 How many of the six INSET sessions did you attend?	6
2. Practical	Watching videos, sharing ideas about effective questioning
2. Pedagogical	Ideas on construction and metacognition I use in all other lessons particularly A level
2. Professional	Sharing ideas and hearing opinions of other teacher
3. Have you ever had the	Yes Martina doing a lesson and doing CASE pre-

## Appendix 8c: Feedback on CASE INSET

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opportunity to be observed teaching CASE or observe a colleague?	test.
4 What would you like covered in any further INSET or coaching sessions?	No comment made

## Appendix 9: Guidelines for completing journal

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There are no rules for how this should be completed. It should essentially be used as tool for reflection and evaluation that can be analysed by me as part of the research. The main areas I suggest focusing on are:

- Reflection/evaluation about lessons – what went well? what didn't go well? -response of students, time spent on each cognitive activity
- Reflection/evaluation after INSET – how has your understanding of the pedagogy changed? how do you intend to incorporate this into your lessons?
- Reflection/evaluation after lesson observations – what techniques worked well? How did students respond to questioning? how did students respond to the different cognitive activities?
- Reflection/evaluation after interviews – what progress is being made? what do you need to focus on?
- Reflection/evaluation on discussion with other teachers – sharing of ideas and good practice, sending an email with advice an activity

ML 6/9/07



## Appendix 10: Research Calendar 2007-2008

### 1<sup>st</sup> half term

Week beginning	Activity	Role
3 <sup>rd</sup> September	<ul style="list-style-type: none"> <li>ML to introduce proposal to SLT</li> <li>ML to have initial meeting with participant teachers</li> <li>ML to introduce research to science department</li> </ul>	Researcher  Researcher  Researcher
10 <sup>th</sup> September	<ul style="list-style-type: none"> <li>Participant teachers to complete questionnaires</li> <li>ML to conduct CASE pre-tests with Yr 7 classes</li> </ul>	Researcher
17 <sup>th</sup> September	ML to conduct CASE pre-tests with Yr 7 classes	Researcher
24 <sup>th</sup> September	26 <sup>th</sup> September – INSET I 4-5pm	Trainer
1 <sup>st</sup> October	Observation, activity 1, teacher C Feedback on lesson	Researcher Coach
8 <sup>th</sup> October	Observation, activity 1, teacher B Feedback on lesson Demonstration lesson teacher A	Researcher Coach Trainer
15 <sup>th</sup> October		

### 2<sup>nd</sup> half term

Week beginning	Activity	Role
29 <sup>th</sup> October		
5 <sup>th</sup> November	6 <sup>th</sup> November – INSET II 4-5pm	Trainer
12 <sup>th</sup> November		
19 <sup>th</sup> November	Observation, activity 3, teacher A Feedback on lesson Demonstration lesson teacher B	Researcher Coach Trainer
26 <sup>th</sup> November	Demonstration lesson teacher C	Trainer
3 <sup>rd</sup> December		
9 <sup>th</sup> December	Semi –structured interviews –teachers B & C	Researcher
17 <sup>th</sup> December	Semi –structured interview –teacher A	Researcher

### 3<sup>rd</sup> half term

Week beginning	Activity	Role
7 <sup>th</sup> January		
14 <sup>th</sup> January		
21 <sup>st</sup> January	21 <sup>st</sup> January – INSET III 4-5pm	Trainer
28 <sup>th</sup> January		
4 <sup>th</sup> February		
11 <sup>th</sup> February		

## Appendix 10: Research Calendar 2007-2008

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### 4<sup>th</sup> half term

Week beginning	Activity	Role
25 <sup>th</sup> February		
3 <sup>rd</sup> March		
10 <sup>th</sup> March	Observation ,activity 7, teacher C Feedback on lesson	Researcher Coach
17 <sup>th</sup> March		
25 <sup>th</sup> March		
31 <sup>st</sup> March	Observation ,activity 10, teacher A Feedback on lesson 1 <sup>st</sup> April – INSET IV 4-5pm	Researcher Coach Trainer

### 5<sup>th</sup> half term

Week beginning	Activity	Role
21 <sup>st</sup> April	Observation ,activity 7, teacher B Feedback on lesson	Researcher Coach
28 <sup>th</sup> April	Semi –structured interview –teachers B	Researcher
5 <sup>th</sup> May	Semi –structured interview –teacher A & C 7 <sup>th</sup> May – INSET V 4-5pm	Researcher Trainer
12 <sup>th</sup> May		
19 <sup>th</sup> May		

### 6<sup>th</sup> half term

Week beginning	Activity	Role
2 <sup>nd</sup> June		
9 <sup>th</sup> June		
16 <sup>th</sup> June	Observation ,activity 15, teachers A & C Feedback on lesson	Researcher Coach
23 <sup>rd</sup> June	Observation ,activity 15, teacher B Feedback on lesson	Researcher Coach
30 <sup>th</sup> June	2 <sup>nd</sup> July – INSET VI 2-3pm	Trainer
7 <sup>th</sup> July	Semi –structured interview –teachers A, B & C	Researcher
14 <sup>th</sup> July		

## Appendix 11: List of Acronyms

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BERA	British Educational Research Association
CA	Cognitive Acceleration
CASE	Cognitive Acceleration through Science Education
CPD	Continuing Professional Development
CSMS	Concepts in Secondary Mathematics and Science
DfES	Department for Education and Skills
EPPI	Evidence for Policy and Practice Information
EQUASS	Enhancing the Quality of Argument in School Science
FLC	Fostering a Community of Learners
GTCE	General Teaching Council for England
IE	Instrumental Enrichment
IFS	Institution Focused Study
INSET	IN-SERVICE Training
KS	Key Stage
LA	Local Authority
MA	Master of Arts
MF	Mediating Factor
PCK	Pedagogical Content Knowledge
PKG	Pemantapan Kerja Guru
PD	Professional Development
PGCE	Postgraduate Certificate in Education
PLC	Professional Learning Communities
QCA	Qualifications and Curriculum Authority

## Appendix 11: List of Acronyms

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NQT	Newly Qualified Teacher
RBT	Research Based Thesis
SLT	Senior Leadership Team
SRT	Science Reasoning Tests
TDA	Teacher Development Agency
TGAT	Task Group on Assessment and Testing
TLRP	Teaching and Learning Research Programme
UK	United Kingdom

### **Codes used for analysis**

A&B	Attitudes and Beliefs
C	Collaboration
E	Experimentation
K&U	Knowledge and Understanding
LO	Lesson Observation
M	Modelling
PoC	Process of Change
SoO	Sense of Ownership